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(54) **PHOTOLABILE COMPOUNDS AND METHODS FOR THEIR USE**

PHOTOLABILE VERBINDUNGEN UND VERFAHREN FÜR DEREN VERWENDUNG

COMPOSE PHOTOLABILES ET PROCEDES POUR LEUR UTILISATION

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WO-A-92/10092 **WO-A-95/04160**
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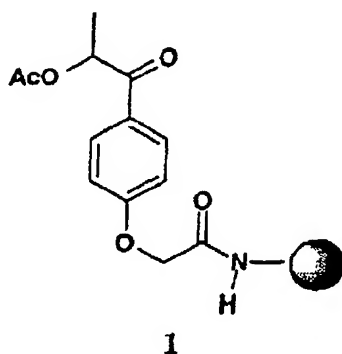
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Description

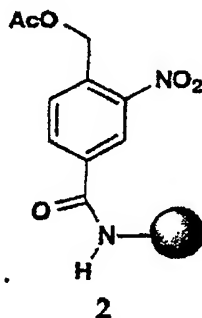
[0001] The present invention is related to the area of chemical synthesis. More specifically, one embodiment of the present invention provides certain photolabile compounds and methods for their use as photocleavable linkers.

[0002] The use of a photolabile molecule as a linker to couple peptides to solid supports and to facilitate the subsequent cleavage reaction has received considerable attention during the last two decades. Photolysis offers a mild method of cleavage which complements traditional acidic or basic cleavage techniques. *See, e.g.,* Lloyd-Williams *et al.* (1993) *Tetrahedron* 49:11065-11133. The rapidly growing field of combinatorial organic synthesis (*see, e.g.,* Gallop *et al.* (1994) *J. Med. Chem.* 37:1233-1251; and Gordon *et al.* (1994) *J. Med. Chem.* 37:1385-1401) involving libraries of peptides and small molecules has markedly renewed interest in the use of photolabile linkers for the release of both ligands and tagging molecules.

[0003] A phenacyl based linking group (see 1 below) has been described. *See* Wang, (1976) *J Org. Chem.* 41:3258.



[0004] An *ortho*-nitrobenzyl support (see 2 below) derived from 4-bromomethyl-3-nitrobenzoic acid has been widely employed as a photolabile support for the generation of both peptide acids and amides. *See* Rich *et al.* (1975) *J. Am. Chem. Soc.* 97:1575-1579 and Hammer *et al.* (1990) *Int. J. Peptide Protein Res.* 36:31-45.



Photolabile support 2, though useful, does suffer from several limitations. For example, workers have been unable to obtain high yields of methionine-containing peptides from the support without substantial contamination with methionine sulfoxide. *See* Rich *supra* and Hammer *supra*. One solution has been to employ methionine sulfoxide throughout the peptide assembly and to subsequently reduce back to methionine to avoid any ambiguities associated with partial oxidation (*see, Lloyd-Williams et al.* (1991) *J. Peptide Protein Res.* 37:58-60 and Lloyd-Williams *et al.* (1993) *Tetrahedron* 49:10069-10078), but this clearly detracts from the usefulness of the technique. This support also suffers from unduly slow cleavage kinetics, with typical photolysis times in organic solvents ranging from 12 to 24 hours. Moreover, photolysis of the support generates a reactive and chromogenic nitroso-aldehyde on the support which can trap liberated compounds and may act as an internal light filter to slow the rate of cleavage. *See* Patchnornik *et al.* (1970) *J. Am. Chem. Soc.* 92:6333-6335.

[0005] Pillai and coworkers have described an α -methyl-*ortho*-nitrobenzyl support designed to eliminate formation

of the nitroso-aldehyde, *but* they observed inefficient release of peptides longer than five residues due to poor swelling of the resin. See Ajayaghosh *et al.* (1988) *Tetrahedron* 44:6661-6666.

[0006] In the course of optimizing the photolithographic synthesis of both peptides (see Fodor *et al.* (1991) *Science* 251:767-773) and oligonucleotides (see Pease *et al.* (1994) *Proc. Natl. Acad. Sci. USA* 91:5022-5026, we had occasion to explore the use of a variety of *ortho*-benzyl compounds as photolabile protecting groups. See PCT patent publication Nos. WO 90/15070, WO 92/10092, and WO 94/10128; see Holmes *et al.* (1994) in *Peptides: Chemistry, Structure and Biology* (Proceedings of the 13th American Peptide Symposium); Hodges *et al.* Eds.; ESCOM: Leiden; pp. 110-12. Examples of these compounds included the 6-nitroveratryl derived protecting groups, which incorporate two additional alkoxy groups onto the benzene ring. Introduction of an α -methyl onto the benzylic carbon facilitated the photolytic cleavage with > 350 nm UV light and resulted in the formation of a nitroso-ketone.

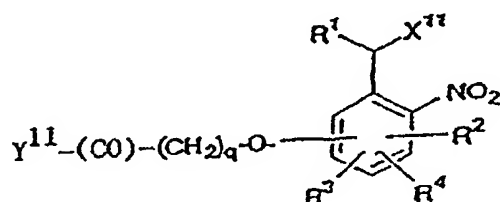
[0007] Photolabile amide protecting groups for C-termini of peptides which rely on the same basic *ortho*-nitro benzyl chemistry have also been reported. See Henricksen *et al.* (1993) *Int. J. Peptide Protein Res.* 41:169-180; Ramesh *et al.* (1993) *J. Org. Chem.* 58:4599-5605; Pillai (1980) *Synthesis* 1-26; and Pillai *et al.* (1979) *Tetrahedron Lett.* 3409-3412. See also Bellof and Mutter (1985) *Chimia* 39:10.

[0008] A photocleavable linker should be stable to variety of reagents (e.g., piperidine, TFA, and the like); be rapidly cleaved under mild conditions; and not generate highly reactive byproducts. The present invention provides such linkers.

[0009] The present invention provides new compounds and methods which find application in solid phase synthesis including the preparation of peptides or small ligand molecules, and libraries thereof, as well as in the preparation of high-density arrays of diverse polymer sequences such as diverse peptides and oligonucleotides. The compounds of the present invention are those which are typically referred to as linking groups, linkers or spacers.

[0010] The novel compounds are useful as linking groups in solid phase synthesis. These compounds are useful as linking groups which are photochemically cleavable.

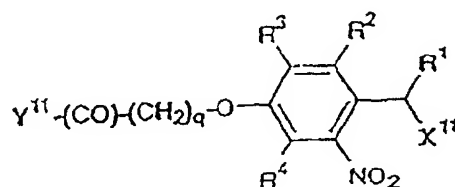
[0011] In one aspect, the present invention provides the use of a compound having the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl, or C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of halogen, -SH, -SP, -OH, -OP, -NH₂, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 10, as a photochemically cleavable linking group. In a preferred embodiment q is an integer of from 1 to 4.

[0012] In one embodiment, the compounds have the formula:

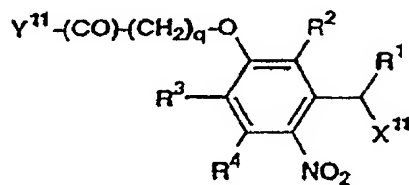


wherein,

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of -Br, -Cl, -OH, -OP, -NH₂, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4. Preferably, R¹ is hydrogen or methyl,

R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, —OH, —O(CO)Cl, —OCH₂Cl, —O(CO)OAr, —OAc, —NH₂, —ODMT, —NHBOC, —NHAc, or —NHFmoc.

[0013] In another embodiment, the compounds have the formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of —Br, —Cl, —OH, —NH₂, —OP, —NHP, in which P is a suitable protecting or activating group, and —NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4.

[0014] In a preferred embodiment, R¹ is hydrogen or methyl, R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, —OH, —O(CO)Cl, —OCH₂Cl, —O(CO)OAr, —OAc, —NH₂, —ODMT, —NHBOC-NHAc, or —NHFmoc.

[0015] In a particularly preferred embodiment, R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 1;

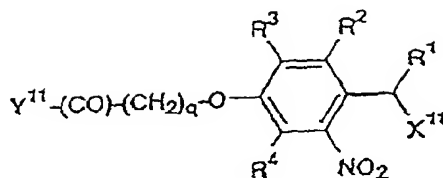
R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 1; or

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 3.

Although these compounds are shown with specific protecting groups, one of skill in the art will readily appreciate that any suitable amine, hydroxy, or carboxy protecting group can be used.

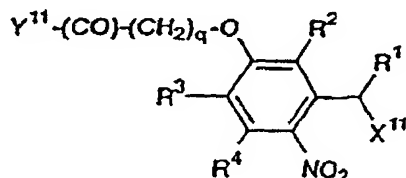
[0016] In another aspect, the present invention provides a compound having the formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ is selected from the group consisting of -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OF, -NHP, in which P is suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, unsubstituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; Y¹¹ is selected from the group consisting of -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of heteroaryl and substituted heteroaryl; and q is integer of from 1 to 4.

[0017] In a related aspect, the present invention provides a compound having the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ is selected from the group consisting of -Br, -Cl, -OH, -NH₂, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, unsubstituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; Y¹¹ is selected from the group consisting of -Br, -Cl, -OH, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4.

[0018] In a preferred embodiment R¹ is methyl, R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBOC-NHAc, or -NHFmoc.

[0019] In a particularly preferred embodiment R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OH, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OH, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OAc, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OAc, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NH₂, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NH₂, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NAC, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NAC, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NHFmoc, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NHFmoc, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -O(CO)Cl, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -O(CO)Cl, and q is 3;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OCH₂Cl, and q is 1;

R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OCH₂Cl, and q is 3;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH; and X¹¹ is -Br, and q is 1;

R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, and q is 3;

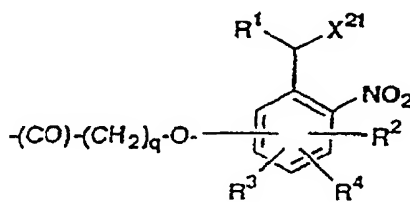
R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OH, and q is 1;

R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —OH, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —OAc, and q is 1;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —OAc, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NH₂, and q is 1;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NH₂, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NAC, and q is 1;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NAC, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NHFmoc, and q is 1;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —NHFmoc, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —O(CO)Cl, and q is 1;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —O(CO)Cl, and q is 3;
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —OCH₂Cl, and q is 1; or
 R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is —OH, and X^{11} is —CH₂Cl, and q is 3.

[0020] According to another aspect of the invention, the photocleavable protecting groups of this invention are incorporated into a composition having the formula:

A-B-L

wherein A is a solid substrate, B is a valence bond or a derivatizing group, and L is a photocleavable linking group having the formula:

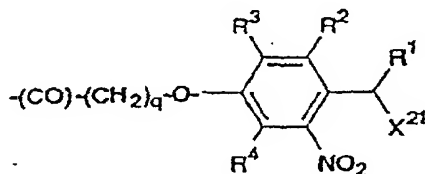


wherein,

R^1 is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R^2 , R^3 and R^4 are each independently hydrogen, C₁-C₈ alkyl, or C₁-C₈ alkoxy; X^{21} is halogen, —SH, —SP, —OH, —NH₂, —OP or —NHP, wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 10. One of skill in the art will readily appreciate that these radicals L are derivatives of the photocleavable linking groups shown above. Preferably, the derivatizing group comprises an amino acid, peptide, or polyether chain having an amine functionality at the termini. More preferably, the derivatizing group will comprise —NH—(CH₂CH₂O)_nCH₂CH₂NH—, —NH—CH₂(CH₂CH₂O)_nCH₂CH₂CH₂NH—, —NH—CH₂(CH₂CH₂CH₂O)_nCH₂CH₂CH₂NH— or —NH—(CH₂)_mO(CH₂)_nO(CH₂)_mNH—, in which n is an integer of from 1 to 10 and m is an integer of from 1 to 6. In a particularly preferred embodiment, the derivatizing group is —NH—(CH₂CH₂O)₂CH₂CH₂NH—.

In another embodiment, either

(a) L has the formula:

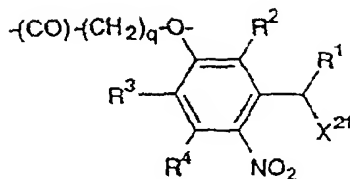


wherein

R^1 is hydrogen, C₁-C₈ alkyl; R^2 and R^4 are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R^3 is C₁-C₈ alkoxy, X^{21} is —Br, —Cl, —OH, —OP, —SH, —SP, —NH₂ or —NHP, wherein P is a suitable protecting or activating

group; and q is an integer of from 1 to 4; or

(b) L has the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X²¹ is -Br, -Cl, -OH, -OP, -SH, -SP, -NH₂ or -NHP, wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 4.

[0021] In a preferred embodiment, R¹ is methyl and R³ is methoxy, and preferably R² and R⁴ are each hydrogen.

[0022] In a particularly preferred embodiment n is 3, R¹ is methyl, R³ is methoxy, R² and R⁴ are each hydrogen, and X²¹ is -OH, -ODMT, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH-Fmoc, -NHAc, or -NH-BOC. e.g., a composition

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NHFmoc, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NHFmoc, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NHFmoc, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NHFmoc, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 1; or

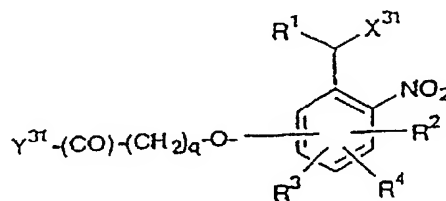
wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 3.

[0023] Yet another aspect of this invention provides methods for utilizing the photocleavable linkers and compositions described above in methods of synthesizing small molecule ligands and peptides, and libraries thereof.

[0024] In a particular embodiment, the present invention provides a method of synthesizing small ligand molecules or peptides on a solid support having optional spacers, said small ligand molecules or peptides being removable there-

from upon application of a suitable energy source, said method comprising the steps of:

(a) providing on the surface of said solid support, a photolabile linking group of formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; X³¹ is halogen, —OH, —OP, —SH, —SP, —NH₂ or —NHP and Y³¹ is Br, Cl, OH, NH₂, SH, OP, SP and NHP, wherein P is a protecting or activating group; and q is an integer of from 1 to 10, to produce a derivatized solid support having attached photolabile linking groups suitably protected with protecting groups;

(b) optionally removing said protecting groups from said derivatized solid support to provide a derivatized solid support having photolabile linking groups with synthesis initiation sites;

(c) optionally activating said solid support to provide a derivatized solid support having photolabile linking groups with activated synthesis sites; and

(d) coupling a first building block to said synthesis initiation sites on said derivatized solid support to produce a solid support having attached building block which is removable therefrom upon application of said energy source.

[0025] A further understanding of the nature and advantages of the inventions herein may be realized by reference to the remaining portions of the specification and the attached drawings.

[0026] Figure 1 illustrates a reaction scheme for the preparation of preferred photocleavable linkers, Compounds 9 and 10.

[0027] Figure 2 illustrates the results achieved by removal of two thiazolidinones from a resin via photolysis. The thiazolidinones were synthesized on a resin having a photocleavable linking group. Figures 2A and 2B show the reactions which produce the two thiazolidinones. Figures 2C and 2D show the HPLC chromatograms of the resulting thiazolidinones and illustrate the purity of each.

[0028] Figure 3 illustrates the results achieved by the photolysis of a cholecystokinin peptide (H-Met-Gly-Trp-Met-Asp-Phe-NH₂) from a resin via photolysis. The peptide was synthesized on a resin having a photocleavable linking group. Figure 3 shows the HPLC chromatogram of the resulting soluble peptide and illustrates the purity of each. The principle peak at 18.3 min. comigrated with authentic CCK peptide and its identity was also confirmed by mass spectroscopy.

[0029] Figure 4 illustrates several anchoring strategies for a variety of functionalities on the cleavable linker.

[0030] Figure 5 provides a schematic illustration of the solid phase synthesis of a beta-lactam using photocleavable linker 9.

I. Terminology

[0031] Unless otherwise stated, the following terms used in the specification and claims have the meanings given below:

Chemical terms:

[0032] "Activating group" refers to those groups which, when attached to a particular functional group or reactive site, render that site more reactive toward covalent bond formation with a second functional group or reactive site. For example, the group of activating groups which can be used in the place of a hydroxyl group include -O(CO)Cl; -OCH₂Cl; -O(CO)OAr, where Ar is an aromatic group, preferably, a p-nitrophenyl group; -O(CO)(ONHS); and the like. The group of activating groups which are useful for a carboxylic acid include simple ester groups and anhydrides. The ester groups include alkyl, aryl and alkenyl esters and in particular such groups as 4-nitrophenyl, N-hydroxylsuccinimide and pentafluorophenol. Other activating groups are known to those of skill in the art.

[0033] "Alkoxy" refers to the group alkyl-O-.

[0034] "Alkyl" refers to a cyclic, branched, or straight chain chemical group containing only carbon and hydrogen, such as methyl, heptyl, $-(CH_2)_2-$, and adamantyl. Alkyl groups can either be unsubstituted or substituted with one or more substituents, e.g., halogen, alkoxy, acyloxy, amino, aryl, hydroxyl, mercapto, carboxy, benzyloxy, phenyl, benzyl, or other functionality which may be suitably blocked, if necessary for purposes of the invention, with a protecting group. When "alkyl" or "alkylene" is used to refer to a linking group or a spacer, it is taken to be a group having two available valences for covalent attachment, for example, $-CH_2CH_2-$, $-CH_2CH_2CH_2-$, $-CH_2CH_2CH(CH_3)CH_2-$ and $-CH_2(CH_2CH_2)_2CH_2-$. Preferred alkyl groups as substituents are those containing 1 to 10 carbon atoms, with those containing 1 to 6 carbon atoms being particularly preferred. Preferred alkyl or alkylene groups as linking groups are those containing 1 to 20 carbon atoms, with those containing 3 to 6 carbon atoms being particularly preferred.

[0035] "Amino" or "amine group" refers to the group $-NR'R''$, where R' and R'' are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl. In a primary amino group, both R' and R'' are hydrogen, whereas in a secondary amino group, either, but not both, R' or R'' is hydrogen.

[0036] An " α -amino acid" consists of a carbon atom, called the α -carbon, to which is bonded an amino group and a carboxyl group. Typically, this α -carbon atom is also bonded to a hydrogen atom and a distinctive group referred to as a "side chain." The hydrogen atom may also be replaced with a group such as alkyl, substituted alkyl, aryl, substituted aryl, heteroaryl, and other groups. The side chains of naturally occurring amino acids are well known in the art and include, for example, hydrogen (as in glycine), alkyl (as in alanine (methyl), valine (isopropyl), leucine (sec-butyl), isoleucine (iso-butyl), and proline $-(CH_2)_3-$), substituted alkyl (as in serine (hydroxymethyl), cysteine (thiomethyl), aspartic acid (carboxymethyl), asparagine, arginine, glutamine, glutamic acid, and lysine), aryl alkyl (as in phenylalanine, histidine, and tryptophan), substituted aryl alkyl (as in tyrosine and thyroxine), and heteroaryl (as in histidine). See, e.g., Harper *et al.* (1977) Review of Physiological Chemistry, 16th Ed., Lange Medical Publications, pp. 21-24.

[0037] In addition to naturally occurring side chains, the amino acids used in the present invention may possess synthetic side chains. A "synthetic side chain" is any side chain not found in a naturally occurring amino acid. For example, a synthetic side chain can be an isostere of the side chain of a naturally occurring amino acid. Naturally occurring and synthetic side chains may contain reactive functionalities, such as hydroxyl, mercapto, and carboxy groups. One skilled in the art will appreciate that these groups may have to be protected to carry out the desired reaction scheme. As stated above, the hydrogen at the α -carbon can also be replaced with other groups; those of skill in the art recognize the medicinal importance of α -methyl amino acids and other α -, α -disubstituted amino acids.

[0038] "Protected amino acid" refers to an amino acid, typically an α -amino acid having either or both the amine functionality and the carboxylic acid functionality suitably protected by one of the groups described above. Additionally, for those amino acids having reactive sites or functional groups on a side chain (*i.e.*, serine, tyrosine, glutamic acid), the term "protected amino acid" is meant to refer to those compounds which optionally have the side chain functionality protected as well.

[0039] "Aryl" or "Ar" refers an aromatic substituent which may be a single ring or multiple rings which are fused together, linked covalently or linked to a common group such as an ethylene or methylene moiety. The aromatic rings may each contain heteroatoms, for example, phenyl, naphthyl, biphenyl, diphenylmethyl, 2,2-diphenyl-1-ethyl, thienyl, pyridyl and quinoxalyl. The aryl moieties may also be optionally substituted with halogen atoms, or other groups such as nitro, carboxyl, alkoxy, phenoxy and the like. Additionally, the aryl radicals may be attached to other moieties at any position on the aryl radical which would otherwise be occupied by a hydrogen atom (such as, for example, 2-pyridyl, 3-pyridyl and 4-pyridyl).

[0040] "Aryloxy" refers to the group aryl-O- or heteroaryl-O-.

[0041] "Arylalkyl" or "aralkyl" refers to the groups $R'-Ar$ and $R-HetAr$, where Ar is an aryl group, HetAr is a heteroaryl group, and R' is straight-chain or branched-chain aliphatic group (for example, benzyl, phenylethyl, 3-(4-nitrophenyl) propyl, and the like). Preferred aryl groups include phenyl, 1-naphthyl, 2-naphthyl, biphenyl, phenylcarboxylphenyl (*i.e.*, derived from benzophenone), and the like.

[0042] "Carboxy" or "carboxyl" refers to the group $-R'(COOH)$ where R' is alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heterocyclic, heteroaryl, or substituted heteroaryl.

[0043] "Carboxyalkyl" refers to the group $-(CO)-R'$ where R' is alkyl or substituted alkyl.

[0044] "Carboxyaryl" refers to the group $-(CO)-R'$ where R' is aryl, heteroaryl, or substituted aryl or heteroaryl.

[0045] "Chemical library" or "array" is an intentionally created collection of differing molecules which can be prepared either synthetically or biosynthetically and screened for biological activity in a variety of different formats (e.g., libraries of soluble molecules; and libraries of compounds tethered to resin beads, silica chips, or other solid supports). The term is also intended to refer to an intentionally created collection of stereoisomers.

[0046] "Combinatorial synthesis strategy" or "combinatorial chemistry" refers to an ordered strategy for the parallel synthesis of diverse compounds by sequential addition of reagents which leads to the generation of large chemical libraries. Thus, combinatorial chemistry refers to the systematic and repetitive, covalent connection of a set of different "building blocks" of varying structures to each other to yield large arrays of diverse molecular entities.

[0047] "Linker" refers to a molecule or group of molecules attached to a solid support and spacing a synthesized compound from the solid support, such as for exposure/binding to a receptor.

[0048] "Polyethylene glycol" refers to those molecules which have repeating units of ethylene glycol, for example, hexaethylene glycol ($\text{HO}-(\text{CH}_2\text{CH}_2\text{O})_5-\text{CH}_2\text{CH}_2\text{OH}$). When the term "polyethylene glycol" is used to refer to linking groups and spacer groups, it would be understood by one of skill in the art that other polyethers or polyols could be used as well (*i.e.*, polypropylene glycol or mixtures of ethylene and propylene glycols).

[0049] "Predefined region" refers to a localized area on a solid support which is, was, or is intended to be used for formation of a selected molecule and is otherwise referred to herein in the alternative as a "selected" region. The predefined region may have any convenient shape, *e.g.*, circular, rectangular, elliptical, wedge-shaped, etc. For the sake of brevity herein, "predefined regions" are sometimes referred to simply as "regions." In some embodiments, a predefined region and, therefore, the area upon which each distinct compound is synthesized is smaller than about 1 cm² or less than 1 mm². Within these regions, the molecule synthesized therein is preferably synthesized in a substantially pure form. In additional embodiments, a predefined region can be achieved by physically separating the regions (*i.e.*, beads, resins, gels, etc.) into wells, trays, etc..

[0051] "Protecting group" refers to a chemical group that exhibits the following characteristics: (1) reacts selectively with the desired functionality in good yield to give a derivative that is stable to the projected reactions for which protection is desired; (2) can be selectively removed from the derivatized solid support to yield the desired functionality; and (3) is removable in good yield by reagents compatible with the other functional group(s) generated in such projected reactions. Examples of protecting groups can be found in Greene *et al.* (1991) *Protective Groups in Organic Synthesis*, 2nd Ed. (John Wiley & Sons, Inc., New York). Preferred protecting groups include photolabile protecting groups (such as methylnitropiperonyloxycarbonyl (Menpoc), methylnitropiperonyl (Menp), nitroveratryl (Nv), nitroveratryloxycarbonyl (Nvoc), or nitroveratryloxymethyl ether (Nvom)); acid-labile protecting group (such as Boc or DMT); base-labile protecting groups (such as Fmoc, Fm, phosphonoethoxycarbonyl (Peoc, *see* Kunz (1976) *Chem. Ber.* 109:2670); groups which may be removed under neutral conditions (*e.g.*, metal ion-assisted hydrolysis), such as DBMB (*see* Chattopadhyaya *et al.* (1979) *J.C.S. Chem. Comm.* 987-990), allyl or alloc (*see, e.g.*, Greene and Wuts, "Protective Groups in Organic Synthesis", 2nd Ed., John Wiley & Sons, Inc., New York, NY (1991), 2-haloethyl (*see* Kunz and Buchholz (1981) *Angew. Chem. Int. Ed. Engl.* 20:894), and groups which may be removed using fluoride ion, such as 2-(trimethylsilyl)ethoxymethyl (SEM), 2-(trimethylsilyl)ethyloxycarbonyl (Teoc) or 2-(trimethylsilyl)ethyl (Te) (*see, e.g.*, Lipshutz *et al.* (1980) *Tetrahedron Lett.* 21:3343-3346)); and groups which may be removed under mild reducing conditions (*e.g.*, with sodium borohydride or hydrazine), such as Lev. *Id.* at 30-31, 97, and 112. Particularly preferred protecting groups include Fmoc, Fm, Menpoc, Nvoc, Nv, Boc, CBZ, allyl, alloc, Npeoc (4-nitrophenethyloxycarbonyl) and Npeom (4-nitrophenethyloxy-methyloxy).

[0052] "Solid support", "support", and "substrate" refer to a material or group of materials having a rigid or semi-rigid surface or surfaces. In many embodiments, at least one surface of the solid support will be substantially flat, although in some embodiments it may be desirable to physically separate synthesis regions for different compounds with, for example, wells, raised regions, pins, etched trenches, or the like. According to other embodiments, the solid support (s) will take the form of beads, resins, gels, microspheres, or other geometric configurations.

[0053] Isolation and purification of the compounds and intermediates described herein can be effected, if desired, by any suitable separation or purification procedure such as, for example, filtration, extraction, crystallization, column chromatography, thin-layer chromatography, thick-layer (preparative) chromatography, distillation, or a combination of these procedures. Specific illustrations of suitable separation and isolation procedures can be had by references to the examples hereinbelow. However, other equivalent separation or isolation procedures can, of course, also be used.

[0054] Ligand: A ligand is a molecule that is recognized by a receptor. Examples of ligands which can be synthesized using the methods and compounds of this invention include, but are not restricted to, agonists and antagonists for cell membrane receptors, toxins and venoms, viral epitopes, hormones, opiates, steroids, peptides, enzyme substrates, cofactors, drugs, lectins, sugars, oligonucleotides, nucleic acids, oligosaccharides, and proteins.

[0055] Receptor: A receptor is a molecule that has an affinity for a ligand. Receptors may be naturally-occurring or manmade molecules. They can be employed in their unaltered state or as aggregates with other species. Receptors may be attached, covalently or noncovalently, to a binding member, either directly or via a specific binding substance. Examples of receptors which can be employed by this invention include, but are not restricted to, antibodies, cell membrane receptors, monoclonal antibodies and antisera reactive with specific antigenic determinants, viruses, cells, drugs, polynucleotides, nucleic acids, peptides, cofactors, lectins, sugars, polysaccharides, cellular membranes, and organelles. Receptors are sometimes referred to in the art as anti-ligands. As the term receptors is used herein, no difference in meaning is intended. A "Ligand Receptor Pair" is formed when two molecules have combined through molecular recognition to form a complex.

[0056] Specific examples of receptors which can be investigated using ligands and libraries prepared using the methods and compounds of this invention include but are not restricted to:

a) Microorganism receptors: Determination of ligands that bind to microorganism receptors such as specific transport proteins or enzymes essential to survival of microorganisms would be a useful tool for discovering new classes of antibiotics. Of particular value would be antibiotics against opportunistic fungi, protozoa, and bacteria resistant to antibiotics in current use.

b) Enzymes: For instance, a receptor can comprise a binding site of an enzyme such as an enzyme responsible for cleaving a neurotransmitter; determination of ligands for this type of receptor to modulate the action of an enzyme that cleaves a neurotransmitter is useful in developing drugs that can be used in the treatment of disorders of neurotransmission.

c) Antibodies: For instance, the invention may be useful in investigating a receptor that comprises a ligand-binding site on an antibody molecule which combines with an epitope of an antigen of interest; determining a sequence that mimics an antigenic epitope may lead to the development of vaccines in which the immunogen is based on one or more of such sequences or lead to the development of related diagnostic agents or compounds useful in therapeutic treatments such as for autoimmune diseases (e.g., by blocking the binding of the "self" antibodies).

d) Nucleic Acids: Sequences of nucleic acids may be synthesized to establish DNA or RNA binding sequences that act as receptors for synthesized sequence.

e) Catalytic Polypeptides: Polymers, preferably antibodies, which are capable of promoting a chemical reaction involving the conversion of one or more reactants to one or more products. Such polypeptides generally include a binding site specific for at least one reactant or reaction intermediate and an active functionality proximate to the binding site, which functionality is capable of chemically modifying the bound reactant. Catalytic polypeptides and others are described in, for example, PCT Publication No. WO 90/05746, WO 90/05749, and WO 90/05785.

f) Hormone receptors: Determination of the ligands which bind with high affinity to a receptor such as the receptors for insulin and growth hormone is useful in the development of, for example, an oral replacement of the daily injections which diabetics must take to relieve the symptoms of diabetes or a replacement for growth hormone. Other examples of hormone receptors include the vasoconstrictive hormone receptors; determination of ligands for these receptors may lead to the development of drugs to control blood pressure.

g) Opiate receptors: Determination of ligands which bind to the opiate receptors in the brain is useful in the development of less-addictive replacements for morphine and related drugs.

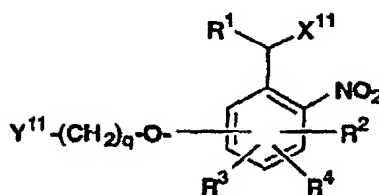
[0057] Channel Block: A material having a plurality of grooves or recessed regions on a surface thereof. The grooves or recessed regions may take on a variety of geometric configurations, including but not limited to stripes, circles, serpentine paths, or the like. Channel blocks may be prepared in a variety of manners, including etching silicon blocks, molding or pressing polymers, etc.

[0058] Abbreviations: The following abbreviations are intended to have the following meanings:

Boc =	t-butyloxycarbonyl
BOP =	benzotriazol-1-yloxytris(dimethylamino) phosphonium hexafluorophosphate
DCC =	dicyclohexylcarbodiimide
Ddz =	dimethoxydimethylbenzyloxy
DIC =	diisopropylcarbodiimide
DMT =	dimethoxytrityl
Fmoc =	fluorenylmethyloxycarbonyl
HBTU =	2-(1H-benzotriazol-1-yl)-1,1,3,3-tetramethyluronium hexafluorophosphate
HOBt =	1-hydroxybenzotriazole
Menpoc =	methylnitropiperonyloxycarbonyl
Menp =	methylnitropiperonyl
Nv =	nitroveratryl
Nvoc =	6-nitroveratryloxycarbonyl and other photoremovable groups
OPfp =	pentafluorophenyl
OSu =	N-succinimidyl (also known as NHS)
PG =	protective group
TFA =	trifluoroacetic acid

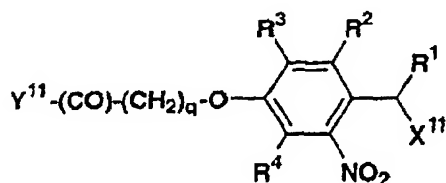
II. General

[0059] The present invention provides novel compounds which are useful as photochemically cleavable linking groups which can be represented by the formula:



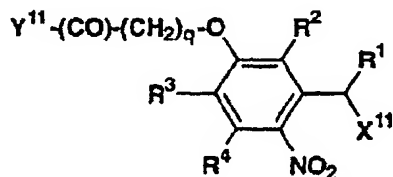
in which R¹ is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl, or C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently halogen, —SH, —SP, —OH, —OP, —NH₂, —NHP, in which P is a suitable protecting or activating group, and —NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 10, preferably from 1 to 4.

[0060] In one group of embodiments, the compounds are represented by the formula:



in which R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently —Br, —Cl, —OH, —NH₂, —OP, —NHP, in which P is a suitable protecting or activating group, and —NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4. In particularly preferred embodiments, R¹ is hydrogen or methyl, R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, —OH, —O(CO)Cl, —OCH₂Cl, —O(CO)OAr, —OAc, —NH₂, —ODMT, —NHBOC, —NHAc, or —NHFmoc.

[0061] In another group of embodiments, the compounds are represented by the formula:



in which the symbols R¹, R², R³, R⁴, X¹¹, Y¹¹ and q represent those groups described above for the first group of embodiments. As above, embodiments which are particularly preferred are those in which R¹ is methyl, R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, —OH, —O(CO)Cl, —OCH₂Cl, —O(CO)OAr, —OAc, —NH₂, —ODMT, —NHBOC, —NHAc, or —NHFmoc.

[0062] Exemplary of the photochemically cleavable linking groups of the present invention are structures 3-6, below.



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by means of a derivatizing group "B". One can, of course, incorporate a wide variety of derivatizing groups, depending upon the application and the effect desired. For instance, one can select derivatizing groups that impart hydrophobicity, hydrophilicity, or steric bulk to achieve desired effects on properties such as coupling or binding efficiency. In one aspect of the invention, the derivatizing group will comprise an amino acid or peptide. For example, branched derivatizing groups, i.e., derivatizing groups with bulky side chains such as the derivatizing group, Fmoc-Thr(tBu), are used to provide rigidity to or to control spacing of the molecules on the solid support in a library or between a molecule and a tag in the library. Particularly preferred derivatizing groups derived from amino acids or peptides include T, EGEGET, and SVT.

[0074] In some embodiments, cleavable linkers will be used to facilitate an assay or detection step. Specifically, the advent of methods for the synthesis of diverse chemical compounds on solid supports has resulted in the genesis of a multitude of diagnostic applications for such chemical libraries. A number of these diagnostic applications involve contacting a sample with a solid support, or chip, having multiple attached biological polymers such as peptides and oligonucleotides, or other small ligand molecules synthesized from building blocks in a stepwise fashion, in order to identify any species which specifically binds to one or more of the attached polymers or small ligand molecules. For example, the use of VLSIPS and ESL technologies, disclosed in US Patent No. 5,143,854, and other synthesis and screening methodologies often requires that the support used to assemble the ligands also be used to display the ligands for biological binding experiments. As a result, any linking groups used in preparation of the ligands must perform well in the organic environment used in synthesizing the ligands as well as the aqueous environment typically used in binding assays. By changing the particular derivatizing group and the resulting hydrophilic/hydrophobic properties of the compositions claimed herein, often the presentation of a ligand or peptide to certain receptors, proteins or drugs can be improved.

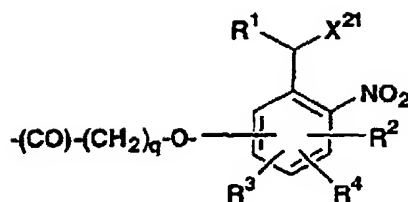
[0075] Prior to attachment to the solid substrate the derivatizing group will have a substrate attaching group at one end, and a reactive site at the other end. The reactive site will be a group which is appropriate for attachment to the photocleavable linking group, L. Groups which are suitable for attachment to a linking group include amine, hydroxyl, thiol, carboxylic acid, ester, amide, isocyanate and isothiocyanate.

[0076] Preferably, the derivatizing group is a polymer chain having amine or hydroxyl functional groups at the termini. In one group of preferred embodiments, the derivatizing group comprises an amino acid, peptide, or polyether chain having an amine functionality at the termini. More preferably, the derivatizing group is $\text{—NH—(CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{NH—}$, $\text{—NH—CH}_2\text{(CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{CH}_2\text{NH—}$, $\text{—NH—CH}_2\text{(CH}_2\text{CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{CH}_2\text{NH—}$ or $\text{—NH—(CH}_2\text{)}_m\text{O(CH}_2\text{)}_n\text{O(CH}_2\text{)}_m\text{NH—}$, in which n is an integer of from 1 to 10 and m is an integer of from 1 to 6. In a particularly preferred embodiment, the derivatizing group is $\text{—NH—(CH}_2\text{CH}_2\text{O)}_2\text{CH}_2\text{CH}_2\text{NH—}$.

[0077] According to the needs of the practitioner, the derivatizing groups can also be combined, for example, by combining an amino acid or peptide derivatizing group with a polymer chain having the appropriate functionality at both termini. Particularly preferred derivatizing groups of this class include PEG₁₅T, PEG₁₉T, PEG₂₀T, PEG₂₄T, and PEG₃₀T, wherein the polymer chains have the structures shown below:

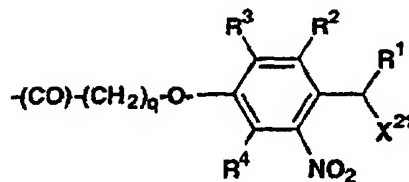
Abbreviation	Structure
PEG ₁₅	$\text{—NH—(CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{NH—(CO)CH}_2\text{CH}_2\text{CH}_2\text{CO—}$, where n is 2
PEG ₁₉	$\text{—NH—(CH}_2\text{)}_m\text{O(CH}_2\text{)}_n\text{O(CH}_2\text{)}_m\text{NH—(CO)CH}_2\text{CH}_2\text{CH}_2\text{CO—}$, where m is 3 and n is 4
PEG ₂₀	$\text{—NH—CH}_2\text{(CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{CH}_2\text{NH—(CO)CH}_2\text{CH}_2\text{CH}_2\text{CO—}$, where n is 3
PEG ₂₄	$\text{—NH—(CH}_2\text{CH}_2\text{O)}_n\text{CH}_2\text{CH}_2\text{NH—(CO)CH}_2\text{CH}_2\text{CH}_2\text{CO—}$, where n is 5
PEG ₃₀	The dimer of PEG ₁₅

[0078] Linking groups used in the present compositions which are photochemically cleavable are represented by radicals of the formula:



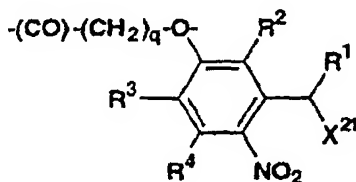
in which R^1 is hydrogen, $\text{C}_1\text{-C}_8$ alkyl, aryl or arylalkyl; R^2 , R^3 and R^4 are each independently hydrogen, $\text{C}_1\text{-C}_8$ alkyl, or $\text{C}_1\text{-C}_8$ alkoxy; X^{21} is halogen, ---SH , ---SP , ---OH , ---NH_2 , ---OP or ---NHP , wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 10. One of skill in the art will readily appreciate that these linking groups are analogous to those described above with the replacement of the Y^{11} group by a valence bond or derivatizing group.

[0079] In one group of preferred embodiments, L has the formula:



in which R^1 is hydrogen, $\text{C}_1\text{-C}_8$ alkyl; R^2 and R^4 are each independently hydrogen, $\text{C}_1\text{-C}_8$ alkyl or $\text{C}_1\text{-C}_8$ alkoxy; R^3 is $\text{C}_1\text{-C}_8$ alkoxy; X^{21} is ---Br , ---Cl , ---OH , ---OP , ---SH , ---SP , ---NH_2 or ---NHP , wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 4. In further preferred embodiments R^1 is hydrogen or methyl and R^3 is methoxy. More preferably, R^1 is methyl, R^3 is methoxy, and R^2 and R^4 are each hydrogen. Still further preferred are those compounds in which n is 3, R^1 is methyl, R^3 is methoxy, R^2 and R^4 are each hydrogen, and X^{21} is ---OH , ---ODMT , $\text{---O}(\text{CO})\text{Cl}$, $\text{---OCH}_2\text{Cl}$, $\text{---O}(\text{CO})\text{OAr}$, ---OAc , ---NH-Fmoc , ---NHAc , or ---NH-BOC .

[0080] In another group of preferred embodiments, L has the formula:



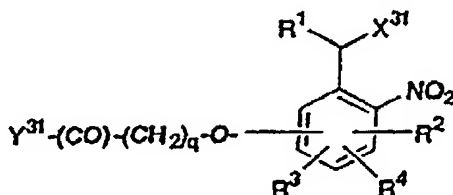
in which the symbols R^1 , R^2 , R^3 , R^4 , X^{21} and q represent those groups described above for the first group of embodiments. As above, embodiments which are particularly preferred are those in which R^1 is methyl and R^3 is methoxy. More preferably, R^1 is methyl, R^3 is methoxy, and R^2 and R^4 are each hydrogen. Still further preferred are those compounds in which n is 3, R^1 is methyl, R^3 is methoxy, R^2 and R^4 are each hydrogen, and X^{21} is ---OH , ---ODMT , $\text{---O}(\text{CO})\text{Cl}$, $\text{---OCH}_2\text{Cl}$, $\text{---O}(\text{CO})\text{OAr}$, ---OAc , ---NH-Fmoc , ---NHAc , or ---NH-BOC .

[0081] The compositions of the present invention can be prepared by standard manipulations of methods already described herein which are well known to those of skill in the art from the diamine derivatives of commercially available polyglycols. For example, hexaethylene glycol (Aldrich Chemical Company, Milwaukee, Wisconsin, USA) can be treated with *p*-toluenesulfonyl chloride and ammonia to produce a glycol derivative having amino groups at the chain termini. Other methods for the synthesis of the derivatizing group subunit begin with pentaethylene glycol and proceed with a one carbon homologation on each termini via treatment of the diol with *p*-toluenesulfonyl chloride followed by cyanide ion. Reduction of the resultant dinitrile provides the corresponding diamine. Still other diamines which are useful in the present linking groups are available from Fluka Chemical Co. (Ronkonkoma, New York, USA).

III. Use in synthesisA. General overview

[0082] In yet another aspect, the present invention provides methods for the preparation of small ligand molecules or peptides on a solid support such that the small ligand molecules or peptides are removable from the support upon the application of a suitable energy source. These methods are applicable to the solid phase synthesis of a single molecule or libraries of molecules, as described in greater detail hereinbelow.

[0083] In the first step of the present method, a photolabile linking group is attached to a solid support. The photolabile linking group is represented by the formula:



in which R^1 is hydrogen, C_1 - C_8 alkyl, aryl or arylalkyl; R^2 , R^3 and R^4 are each independently hydrogen, C_1 - C_8 alkyl or C_1 - C_8 alkoxy; X^{31} is halogen, $-OH$, $-OP$, $-SH$, $-SP$, $-NH_2$ or $-NHP$ and Y^{31} is Br, Cl, OH, NH_2 , SH, OP, SP and NHP, wherein P is a protecting or activating group; and q is an integer of from 1 to 10. In this step, attachment to the solid support occurs through Y^{31} , or alternatively through the carbonyl group attached to Y^{31} .

[0084] The extent of coupling of the linkers to commercially available amino-supports to afford the corresponding photolabile supports can be determined by conventional Kaiser test. Despite the sensitivity of the supports towards photolytic cleavage, they can be handled without any special precautions other than avoiding direct exposure to sunlight or UV light. The supports can be handled under subdued laboratory lights and stored in foil-wrapped vials.

[0085] In an optional second step, protecting groups, where present on X^{31} , are removed from the resulting derivatized solid support. In those applications in which a number of diverse small ligand molecules are to be synthesized on the support, the protecting groups may be selectively removed from one region at a time. Methods for this selective removal are described in US Patent No 5,384,261 (Application Serial No. 07/796,243, filed November 22, 1991). The removal of protecting groups provides a synthesis initiation site upon which the small ligand molecules can be prepared.

[0086] In an optional third step, the synthesis sites on the solid support are activated. For example, a hydroxyl group can be converted to the corresponding $-OP$ group wherein P is an activating group as defined above. Similarly, amine and carboxyl groups can also be activated using methods known in the art.

[0087] In the fourth step of the present method, small ligand molecules or polymers are coupled to the synthesis initiation site. This coupling can involve either the attachment of the entire small ligand molecule or polymer, or it can involve the synthesis of the molecules in a stepwise fashion on the synthesis initiation site. In those embodiments in which the molecules are synthesized in stepwise fashion on the synthesis initiation site, the synthesis can proceed by any of the compatible means discussed under the General Methods section hereinbelow.

[0088] Various formats for attaching the molecules or building blocks to the linker are shown in Figure 4. For example, when X^{31} comprises a $-NH_2$ group, compounds bearing a carboxylic acid, isocyanate, carbonyls, or sulfonyl halide, and alkylating agents can be directly coupled to the amine functionality. Compounds bearing a carboxylic acid can be coupled directly to X^{31} when it comprises a $-OH$ group. Alternatively, the X^{31} group can be converted to a halogen and preferably, a bromine, or various activating groups as shown in Figure 4 for coupling to a variety of functionalities.

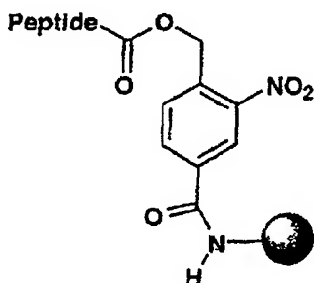
B. Small Molecule Ligand Synthesis

[0089] The photocleavable linkers described herein have been used in a variety of peptide and small molecule ligand solid phase syntheses. For example, pyrrolidines; diketopiperazines; beta-lactams; and dihydropyridines, dihydropyrimidines, pyridines, and pyrimidines and libraries thereof, can be prepared using the photocleavable linkers described herein.

[0090] The photocleavable linkers described herein have been utilized in the synthesis and cleavage of a support-bound 4-thiazolidinone. The stability of the linker and the 4-thiazolidinone towards typical TFA deprotection conditions was examined by incubating the thiazolidinone bound-support with a standard TFA-scavenger cocktail containing phenol, thioanisole, water, ethanedithiol, and TFA for 2 hours at room temperature. Analysis of the support by fast ^{13}C

NMR indicated that both components were stable to these conditions. Photolytic cleavage in pH 7.4 phosphate buffered saline (PBS) containing 5% DMSO (simulating a cleavage cocktail appropriate for transfer to a biological assay) was performed by irradiating for 3 hours with 365 nm UV light. The liberated 4-thiazolidinone was obtained in 95% purity and >90% yield.

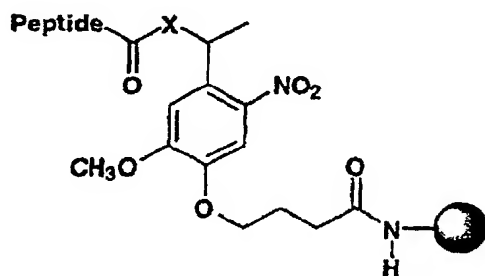
[0091] Studies on model compounds in solution under identical conditions demonstrated that linker 9 cleaved 200-700 times faster than the ortho-nitrobenzyl support previously known and shown below:



See Rich *supra* and Hammer *supra*.

C. Peptide Synthesis

[0092] The use of the photocleavable linkers described herein to assemble and cleave peptides has also been examined. For example, a cholecystokinin peptide (H-Met-Gly-Trp-Met-Asp-Phe-NH₂) bound to cleavable linker 9 was prepared in a stepwise fashion and then subjected to photolytic cleavage conditions. The peptide was assembled on the support with a TentaGel resin shown below:



9 (X is NH) and 10 (X is O)

where X is O or X is NH, using Fmoc amino acids with standard chain protecting groups. After final Fmoc removal, the peptide was acylated with acetic anhydride before being side chain deprotected with TFA (containing phenol, water, thioanisole, and ethanedithiol). The supports were found to be quite stable to exposure of high concentrations of TFA (up to 100% for two hours).

[0093] The support-bound peptide was found to cleave with 1 hour of irradiation in the presence of hydrazine as scavenger to afford the desired CCK peptide in 86% purity (75% yield) with minimal amounts of oxidation. See Figure 3. In the absence of hydrazine as scavenger, the peptide was of comparable purity, although the rate of cleavage was lower.

D. Use of Scavengers

[0094] The photocleavable linkers described herein produce nitroso-ketone byproducts upon photolysis. Although these byproducts remain attached to the support while the liberated compound diffuses away, they may still potentially trap the released compound or form chromogenic species which may act as internal light filters to slow the rate of cleavage. Accordingly, depending on the reaction scheme employed, in some embodiments, a scavenger is employed during the photolysis reaction, typically in the range of 10-100 mM. Preferred scavengers include hydrazine, ethanolamine, mercaptoethanol, and dithiothreitol. A particularly preferred scavenger is hydrazine.

III. General Methods

[0095] The compounds, compositions and methods of the present invention can be used in a number of solid phase synthesis applications, including light-directed methods, flow channel and spotting methods, pin-based methods and bead-based methods.

A. Bead Based Methods

[0096] A method which is particularly useful for synthesis of polymers and small ligand molecules on a solid support "bead based synthesis." A general approach for bead based synthesis is described in ; Lam *et al.* (1991) Nature 354: 82-84; and Houghten *et al.* (1991) Nature 354:84-86.

[0097] A large plurality of beads are suspended in a suitable carrier (such as a solvent) in a parent container. The beads are provided with a photocleavable-linker having an active site. The active site is protected by an optional protecting group. In a first step of the synthesis, the beads are divided for coupling into separate containers. If present, the protecting groups are then removed and a first portion of the molecule to be synthesized is added to the various containers. For the purposes of this brief description, the number of containers will be limited to three, and the building blocks denoted as A, B, C, D, E, and F. The protecting groups are then removed and a first portion of the molecule to be synthesized, i.e., the first building block, is added to each of the three containers (*i.e.*, A is added to container 1, B is added to container 2 and C is added to container 3).

[0098] Thereafter, the various beads are washed of excess reagents as appropriate, and remixed in the parent container. Again, it will be recognized that by virtue of the large number of beads utilized at the outset, there will similarly be a large number of beads randomly dispersed in the parent container, each having a particular first portion of the monomer to be synthesized on a surface thereof.

[0099] Thereafter, the various beads are again divided for coupling in another group of three containers. The beads in the first container are deprotected and exposed to a second building block (D), while the beads in the second and third containers are coupled to molecule portions E and F respectively. Accordingly, molecules AD, BD, and CD will be present in the first container, while AE, BE, and CE will be present in the second container, and molecules AF, BF, and CF will be present in the third container. Each bead, however, will have only a single type of molecule on its surface. Thus, all of the possible molecules formed on the first portions A, B, C, and the second portions D, E, and F have been formed.

[0100] The beads are then recombined into one container and additional steps such as are conducted to complete the synthesis of the molecules. Each bead, however, will have only a single type of molecule on its surface. In the particular embodiment described herein, all of the possible molecules formed from the various first, second, and third portions have been formed.

[0101] According to some embodiments, the solid support will bear an identifier tag. The identifier tag has a recognizable feature that is, for example, microscopically or otherwise distinguishable in shape, size, mass, charge, or color. This recognizable feature may arise from the optical, chemical, electronic, or magnetic properties of the tag, or from some combination of such properties. In essence, the tag serves to label a molecule and to encode information decipherable at the level of one (or a few) molecules or solid supports. By using identifier tags to track the synthesis pathway that each member of a chemical library has taken, one can deduce the structure of any chemical in the library by reading the identifier tag. Particularly preferred identifier tags include synthetic oligodeoxyribonucleotides. An example of a parallel synthesis of a thiazolidinone with an oligonucleotide tag is shown in Fig. 6 and described further below.

[0102] The identifier tags identify each reaction step that an individual library member or solid support has experienced and record the step in the synthesis series in which each chemical reaction was performed. The tags may be added immediately before, during, or after the chemical reaction, as convenient and compatible with the type of identifier tag, modes of attachment, and chemistry of molecular synthesis.

B. Light-Directed Methods

[0103] "Light-directed" methods (which are one technique in a family of methods known as VLSIPS™ methods) are described in U.S. Patent No. 5,143,854, previously incorporated by reference. The light directed methods discussed in the '854 patent involve activating predefined regions of a substrate or solid support and then contacting the substrate with a preselected monomer solution. The predefined regions can be activated with a light source, typically shown through a mask (much in the manner of photolithography techniques used in integrated circuit fabrication). Other regions of the substrate remain inactive because they are blocked by the mask from illumination and remain chemically protected. Thus, a light pattern defines which regions of the substrate react with a given monomer. By repeatedly activating different sets of predefined regions and contacting different monomer solutions with the substrate, a diverse array of polymers is produced on the substrate. Of course, other steps such as washing unreacted monomer solution

from the substrate can be used as necessary.

[0104] In a similar manner to that described above, the solid support is then exposed to a receptor of interest that is appropriately labeled with, or coupled to another receptor with a label, such as a fluorescent or radioactive label. The solid support is then scanned to determine the location of the label. From knowledge of the composition of the molecule synthesized at each site, it becomes possible to identify the molecule(s) that are complementary to the receptor.

D. Other Methods

[0105] Photocleavable arrays also can be prepared using the pin approach developed by Geysen *et al.*, for combinatorial solid-phase peptide synthesis. A description of this method is offered by Geysen *et al.*, *J. Immunol. Meth.* (1987) 102:259-274, incorporated herein by reference.

[0106] Additional methods applicable to library synthesis on a single substrate are described in US Patent No 5,384,261 (Application Serial No. 07/796,243, filed November 22, 1991). In the methods disclosed in these applications, reagents are delivered to the substrate by either (1) flowing within a channel defined on predefined regions or (2) "spotting" on predefined regions. However, other approaches, as well as combinations of spotting and flowing, may be employed. In each instance, certain activated regions of the substrate are mechanically separated from other regions when the monomer solutions are delivered to the various reaction sites. Photocleavable linkers are particularly suitable for this technology as this delivery method may result in poor synthesis fidelity due to spreading, reagent dilution, inaccurate delivery, and the like. By using a photocleavable linker, rather than a conventional acid-cleavable linker, the purest material can be selectively cleaved from the surface for subsequent assaying or other procedures. More specifically, masks can be used when cleaving the linker to ensure that only linker in the center of the delivery area (i.e., the area

where reagent delivery is most consistent and reproducible) is cleaved. Accordingly, the material thus selectively cleaved will be of higher purity than if the material were taken from the entire surface.

EXAMPLES

[0107] The following examples are included for the purpose of illustrating the invention and are not intended to limit the scope of the invention in any manner.

EXAMPLE 1

[0108] This example illustrates the synthesis of the photochemically cleavable linking group 4-(4-(1-(9-Fluorenylmethoxycarbonylamino)ethyl)-2-methoxy-5-nitrophenoxy)butanoic acid.

A. Preparation of Methyl 4-((4-acetyl-2-methoxy)phenoxy)butanoate

[0109] A slurry of acetovanillone (41.00 g, 246.7 mmol), methyl 4-bromobutyrate (50.15 g, 277 mmol), and K₂CO₃ (51.3 g, 371 mmol) in 200 mL of DMF was stirred at room temperature for 16 hours. Water was added to the reaction mixture until all the K₂CO₃ was dissolved and the solution was then partitioned between EtOAc and Saturated NaCl. The organic phase was dried (MgSO₄), filtered and evaporated to dryness to afford 68.40 g (100% crude yield) of the product ketoester as a light yellow oil, which slowly solidified, MP 48-49°C. Anal. Calcd. for C₁₄H₁₈O₅: C, 63.15; H, 6.81. Found: C, 62.81; H, 6.83.

B. Preparation of Methyl 4-(4-(1-hydroxyiminoethyl-2-methoxy)phenoxy)-butanoate

[0110] To a solution of the keto ester from above (68.4 g) in 225 mL of 2:1 pyridine:H₂O was added hydroxylamine hydrochloride (21.46 g, 309 mmol). After stirring at room temperature for 14 hours the reaction mixture was partitioned between EtOAc and saturated NaCl. The organic phase was dried (MgSO₄), filtered and evaporated to dryness to afford the oxime product as a white solid (69.94 g, 100% crude yield), MP 82-83°C. Anal. Calcd. for C₁₄H₁₉NO₅: C, 59.78; H, 6.81; N, 4.98. found: C, 59.62; H, 6.75; N, 4.81.

C. Preparation of Methyl 4-(4-(1-trifluoroacetamidoethyl-2-methoxy)phenoxy)-butanoate

[0111] A slurry of the oxime from above (69.9 g, 146.7 mmol theoretical) and palladium catalyst (2.5 g of 10% on charcoal, Lancaster Synthesis Inc.) in 400 mL of glacial acetic acid was degassed twice with a water aspirator and placed under 1.1 atmosphere of hydrogen gas via a balloon. An additional 2 g of catalyst was added after 18 h and the balloon was refilled with hydrogen as the gas was consumed. An additional 2 g of catalyst was added after 2 days.

The reaction mixture was filtered after 5 days and the solvent was removed under vacuum. The oily residue was taken up in 600 mL of water and acidified to pH 1 with 6 N HCl. The aqueous phase was washed with Et₂O, then basified with solid NaOH to pH 11 and extracted with EtOAc. The EtOAc extract was dried (MgSO₄), filtered and evaporated to dryness to afford a crude amine as a colorless oil.

[0112] The crude amine was dissolved in 300 mL of pyridine, cooled to 0°C with an ice bath, and was treated with trifluoroacetic anhydride (31 mL, 219 mmol) for 1 hour before being partitioned between EtOAc and saturated NaCl. The organic phase was dried (MgSO₄), filtered and evaporated to dryness to give the crude trifluoroacetamide as a light yellow solid. The solid was recrystallized from CH₂Cl₂/hexanes to afford 71.62 g of white solid (80% overall yield from acetovanillone), MP 96-97°C. Anal. Calcd. for C₁₆H₂₀F₃NO₅: C, 52.89; H, 5.55; N, 3.86. Found: C, 52.76; H, 5.45; N, 3.59.

D. Preparation of Methyl 4-(2-methoxy-5-nitro-4-(1-trifluoroacetamidoethyl)phenoxy)butanoate

[0113] The trifluoroacetamide from above (9.40 g, 25.9 mmol) was dissolved in 200 mL of 70% HNO₃ cooled to 0°C. The solution turned orange in color and was quenched after 2 hours by pouring into water and adjusting the total volume to 2 L. The resultant slurry was chilled to 4°C overnight and filtered to give a light yellow solid. Recrystallization from MeOH/H₂O afforded 9.07 g (86% yield) of product as a light yellow solid, MP 156-157°C. Anal. Calc. for C₁₆H₁₉F₃N₂O₇·0.05 H₂O: C, 46.96; H, 4.70; N, 6.85. Found: C, 46.59; H, 4.78; N, 6.89.

E. Preparation of 4-(4-(1-(9-Fluorenylmethoxycarbonylamino)ethyl)-2-methoxy-5-nitrophenoxy)butanoic acid

[0114] To a solution of the nitro-phenyl compound from above (12.36 g, 30.27 mmol) in 250 mL of warm MeOH was added 1 N NaOH (100 mL, 100 mmol) and the reaction mixture was heated to reflux for 5 hours. The solution was cooled to room temperature and concentrated to about 100 mL with a rotary evaporator. Dioxane (150 mL) and H₂O (100 mL) were added and the pH of the solution was adjusted to pH 9 with 6 N HCl. A solution of Fmoc-Cl (9.83 g, 38.0 mmol) in 100 mL of dioxane was added and an additional 15 mL of dioxane was added to create a homogeneous solution. The pH of the solution was measured to be 4.5 and was adjusted with 1N NaOH to pH 8 over the next 30 minutes. A light yellow precipitate formed as the pH was adjusted. The reaction was quenched after 18 h by adding 100 mL of 1 N HCl and adjusting the total volume to 1 L with H₂O. The precipitate was collected, taken up in 1 L of hot EtOAc, dried over MgSO₄ and was filtered while hot. The solvent was removed under reduced pressure affording a light yellow solid which was triturated with 1 L of hot Et₂O. The solid was collected and was recrystallized from MeOH/10% hexanes to afford 12.78 g (81% yield for two steps) of product as a light yellow solid, MP 200-201°C. Anal. Calc. for C₂₈H₂₈N₂O₈·H₂O: C, 63.94; H, 5.48; N, 5.33. Found: C, 63.57; H, 5.44; N, 5.54.

EXAMPLE 2

[0115] This example illustrates the photochemical cleavage of a series of linking groups.

[0116] Linking groups 1-6 were examined under photolysis conditions routinely employed for the synthesis of both peptides and oligonucleotides. Photolysis was carried out with a Hg(Xe) ARC lamp with a 350-450 nm dichroic reflector at an intensity of 10 mW/cm² at 365 nm. Roughly 90% of the UV light can be considered to be 365 nm in wavelength. The relative photolysis rates were measured in four different solvents (dioxane, methanol, pH 7.4 PBS, and pH 7.4 PBS containing 10 mM DTT). The substrate concentration was 0.1 mM and five time points were taken to determine the quantum yield and half-life for loss of starting material. The observed half-lives are shown in Table 1.

Table 1

Photolysis Half-Lives for Linkers 1-6				
Linking Group	Solvent			
	PBS	DTT/PBS	MeOH	Dioxane
1	348	259	a	a
2	14.1	47.2	362	36.8
3	12.9	7.32	16.2	4.00
4	1.74	1.98	5.81	0.64
5	2.87	2.86	3.85	0.50

^aNo photolysis observed.

Table 1 (continued)

Photolysis Half-Lives for Linkers 1-6				
Linking Group	Solvent			
	PBS	DTT/PBS	MeOH	Dioxane
6	0.69	0.66	0.51	0.17

[0117] As the results in Table 4 indicate, linking groups 3-6 show acceptable rates of photolysis in typical aqueous buffers. Additionally, linking groups 3 and 4 were examined for stability to TFA treatment which is used in some methods of solid phase polymer synthesis (*i.e.*, a "Merrifield"-type peptide synthesis, Fmoc-based peptide synthesis and spotting and flow channel methods associated with VLSIPS™). Linking groups 3 and 4 were each dissolved in both 50% TFA/CH₂Cl₂ and 95% TFA/H₂O for one hour. No decomposition of either linking group was observed by HPLC.

EXAMPLE 3

[0118] This example illustrates the synthesis of thiazolidinones on a resin having a photocleavable linker and the subsequent removal of the thiazolidinones from the resin via photolysis.

A. Thiazolidinone Preparation

[0119] Commercially available H₂N-S-TentaGel (Rapp Polymere, Tübingen, Germany, 1 g, 0.30 mmol/g loading) was washed with DMF and treated with 3 mL of a 0.15 M solution of OBt-activated Fmoc-photolinker (prepared from 310 mg of Fmoc-linker, 92 mg of HOBt, 95 μ L of DIC in 3 mL of DMF) for 1.5 hour. Ninhydrin test indicated a complete reaction had taken place. The resin was washed with DMF and CH₂Cl₂, and was then capped by treatment with 20% Ac₂O and 30% pyridine in 50% CH₂Cl₂ for 30 minutes. The resin was washed (3 x 5 mL DMF, 3 x 5 mL CH₂Cl₂), and dried under vacuum for 1 hour. A portion of the resin (200 mg) was deprotected with 30% piperidine/DMF for 30 minutes and then washed with DMF. A 0.5 M solution of Fmoc-Glycine symmetrical anhydride (prepared from 182 mg of Fmoc-Gly-OH and 50 μ L of DIC in 0.6 mL of DMF) was coupled to the resin for 1 hour, by which time ninhydrin had revealed that a complete reaction had taken place. The resin was washed and capped as above for 30 minutes. Deprotection with piperidine, washing and drying as above gave roughly 150 mg of dry resin. The dried resin was partitioned (roughly 40 mg of resin per vial) into 2 4-mL vials equipped with a screw top closure. ACN (2 mL) and 3 Å molecular sieves (20 - 30 pellets) were added to each vial. Benzaldehyde (152 μ L) and mercaptoacetic acid (300 μ L) was added to the first vial whereas 2,4-dimethoxybenzaldehyde (250 mg) and mercaptoacetic acid (300 μ L) was added to the second vial. Both vials were heated to 70 °C for 2 hours. The vials were cooled to room temperature and the resin was transferred to disposable filter tubes and washed extensively (3 x 5 mL CH₂Cl₂, 3 x 5 mL DMF, 3 x 5 mL CH₂Cl₂, 3 x 5 mL MeOH, 3 x 5 mL CH₂Cl₂, 3 x 5 mL Et₂O).

B. General Photolysis Conditions

[0120] Roughly 2-20 mg of resin were placed in plastic centrifuge tubes equipped with 0.22 μ m membrane filters (Ultrafree-MC Filter Units from Millipore, Bedford, MA) and were suspended in 100 μ L of pH 7.4 PBS buffer. Photolysis were conducted with a 500 W Hg ARC lamp fitted with a 350 - 450 nm dichroic mirror at a 10 mW/cm² power level measured at 365 nm. The samples were irradiated from above for various times with gentle mixing from an orbital shaker table. After photolysis the samples centrifuged and the filtrate collected. The samples were washed with 100 μ L of 50% ACN/H₂O and again centrifuged. The collected filtrates from each sample were analyzed by HPLC for the presence of thiazolidinone. See Figure 2A-2D. The data indicated that both the thiazolidinones were produced in high purity on the resin and that they were stable to the photolysis conditions.

C. Stability towards TFA treatment

[0121] H₂N-S-TentaGel (500 mg) was elaborated in analogy to Example 3 with Fmoc-Gly-OH labeled at the α -carbon with ¹³C (2-¹³C, 99% from Cambridge Isotope Laboratories, Inc., Andover, MA). The resin was capped with Ac₂O as above, deprotected with piperidine, and the Fmoc-photolinker coupled as its OBt-activated ester. The resin was again capped, deprotected, and reacted with unlabeled Fmoc-Glycine-OH as its anhydride. An additional round of capping and deprotection generated the free amine resin. Reaction with 0.75 M PhCHO labeled at the carbonyl (carbonyl-¹³C, 99% from Cambridge Isotope Laboratories, Inc., Andover, MA) and 2.0 M mercaptoacetic acid in ACN containing 3Å

molecular sieves for 2 hours at 70 °C generated the double labeled thiazolidinone resin. The resin was washed extensively (3 x 5 mL CH₂Cl₂, 3 x 5 mL DMF, 3 x 5 mL CH₂Cl₂, 3 x 5 mL MeOH, 3 x 5 mL CH₂Cl₂, 3 x 5 mL Et₂O) and dried under vacuum.

[0122] A portion (20 mg) of the resin was treated with 95% TFA/5% H₂O for 1 hour, followed by washing with CH₂Cl₂, MeOH, and Et₂O. Gel ¹³C NMR analysis of the resin indicated no loss of thiazolidinone, as evidenced by relative integration of the two labeled carbons. Any destruction of either the photolinker or thiazolidinone would be expected to result in the integration of the benzylic carbon to decrease. This experiment demonstrated that both the photolinker and thiazolidinone were stable to TFA treatment.

D. Additional Stability Experiments

[0123] In a separate experiment, an additional 20 mg of resin was treated for 2 hours at room temperature with a solution of phenol (75 mg), thioanisole (50 µL), water (50 µL), ethanedithiol (25 µL), and TFA (1 mL) followed by washing as above. Gel ¹³C NMR analysis of the resin indicated no loss of thiazolidinone or photolabile linker, as evidenced by the relative integration of the two labeled carbons.

EXAMPLE 4

[0124] This example illustrates the synthesis of a CCK peptide on a resin having a photocleavable linker and the subsequent removal of the peptide from the resin via photolysis.

A. Preparation of the CCK Peptide

[0125] The peptide H-Met-Gly-Trp-Met-Asp-Phe was prepared on TentaGel resin (25 mg) bearing the photolabile linker 9 according to the synthesis cycle described below. All amino acids were N-Fmoc protected. The side chain functionalities of Asp and Trp were protected as the *tert-butyl* ester and Boc carbamate, respectively.

B. Coupling

[0126] To a 0.11 M solution of amino acid in DMF (0.50 mL) were added 0.20 M HATU in DMF (0.25 mL) and 0.60 M N, N-diisopropylethylamine in DMF (0.25 mL). The resulting solution was added to TentaGel bearing an unprotected amine, and the suspension was stirred at room temperature. After 20 minutes, the supernatant was decanted and the resin washed successively with DMF and THF.

C. Capping

[0127] To the resin was added a commercially prepared solution of N-methylimidazole (16%) in THF (0.5 mL) followed by a commercially prepared solution of acetic anhydride (10%) and 2,6-lutidine (10%) in THF (0.50 mL). The resulting suspension was stirred 5 minutes at room temperature. The supernatant was then decanted and the resin washed successively with THF and DMF.

D. Amine Deprotection

[0128] Piperidine (20% in DMF, 1.00 mL) was added to the resin and the resulting suspension was stirred 10 minutes at room temperature. The supernatant was then decanted and the resin washed with DMF.

[0129] Following Fmoc removal from the final methionine residue, the resin was washed thoroughly with THF and the solvent evaporated. Side chain protection was removed by treating the resin with 1000:75:50:50:25 TFA/phenol/water/thioanisole/ethanedithiol (0.40 mL) and allowing the resulting suspension to stand 1 hour at room temperature with occasional agitation.

E. Photolytic Release

[0130] 50 Beads bearing the fully-deprotected peptide were placed in one well of a 96-well polystyrene microtiter plate and covered with 75 µL of a 1:1 solution of DMSO and PBS containing 0.1% hydrazine. A glass slide was fixed on top of the plate, which was then irradiated for one hour. After irradiation, the supernatant was decanted from the beads and analyzed directly by reverse phase HPLC, as shown in Figure 3. The product peptide, which co-eluted with authentic material, was obtained in 70% yield. MS (ESI) *m/z* 786 (MH⁺).

EXAMPLE 5

[0131] This example illustrates the preparation of a bromo-photocleavable linker on a resin.

[0132] TentaGel S NH₂ (10 g, 130 µm particle size, 0.29 mmol/g loading; from Rapp Polymere, Tübingen Germany) was washed with DMF (50 mL) and treated with 30% piperidine in DMF (20 mL) for 10 minutes. The resin was then extensively washed with DMF and treated with a 0.5 M solution of DIC/HOBt-activated alcohol photolinker (prepared as above from 2.26 g (7.55 mmol) of 4-(4-(1-hydroxyethyl)-6-methoxy-3-nitrophenoxy)butyric acid, HOBt (1.2 g, 8.88 mmol), a solution of DIC in DMF (1..20 mL, 7.66 mmol) in DMF (15 mL) for 18 hours. Conventional ninhydrin colorimetric test indicated that complete acylation of the resin had taken place. The resin was washed with DMF (100 mL), CH₂Cl₂ (100 mL), methanol (100 mL), and diethyl ether (50 mL), and was dried overnight *in vacuo*.

[0133] A 2.5 g aliquot of the above resin was suspended in CH₂Cl₂ for 30 minutes, filtered, and was then treated with 12 mL of a 0.25 M solution of triphenylphosphine dibromide (Lancaster Synthesis, Windham, NH) in CH₂Cl₂ for 4 hours. The resin was washed with CH₂Cl₂ (10 mL), DMF (10 mL), CH₂Cl₂ (10 mL), methanol (10 mL), DMF (10 mL) and was then capped by treatment with 0.25 M acetic anhydride/0.75 M pyridine in DMF for 30 minutes. The resin was washed as above and dried overnight *in vacuo* to give the bromolinker resin.

EXAMPLE 6

[0134] This example illustrates the synthesis of a representative derivatizing group, Fmoc-15-ATOM-PEG

[0135] To a solution of 2,2'-(ethylenedioxy)-diethylamine (75 mL, 511 mmol) (Fluka Chemie AG, Switzerland) in 1 L of dry *p*-dioxane was slowly added a solution of glutaric anhydride (11.4 g, 100 mmol) in 100 mL of dry *p*-dioxane over 1 hour. A viscous white oil formed during the reaction. The solvent was decanted and the oil was triturated with acetone, followed by trituration twice with ethyl ether (until ether phase remains clear). This oily residue was then carried on to the next step without further purification.

[0136] A slurry containing the amino acid from above, diisopropylethylamine (52 mL, 299 mmol) and trimethylsilyl chloride (25 mL, 197 mmol) in 300 mL of CH₂Cl₂ was heated to reflux for 3 h, during which time the solution became homogeneous. The reaction mixture was cooled to 0°C and Fmoc-Cl (27 g, 104 mmol) was added over a four hour period in three equal aliquots. The reaction mixture was allowed to warm to room temperature and stirred for an additional 3 h. The solvent was removed under reduced pressure and the residue was partitioned between Et₂O and 5% NaHCO₃. The organic phase was discarded and the aqueous phase was acidified to pH 2 with 1 N HCl, and extracted with EtOAc. The organic extract was washed (1 N HCl and saturated NaCl), dried (MgSO₄), and evaporated to dryness under reduced pressure. Chromatography on silica gel (5% to 20% AcOH in EtOAc) afforded 32.7 g (65% yield for two steps) of the desired product, N'-Fmoc-N-glutaryl-2,2'-(ethylenedioxy)diethylamine, as a colorless oil which slowly solidified.

EXAMPLE 7

[0137] This example illustrates the synthesis of beta-lactams on a resin having a photocleavable linker and the subsequent removal of the beta-lactams from the resin via photolysis.

[0138] Sasrin-immobilized Fmoc-protected photolinker was prepared as described above. The resin was deprotected with 30% piperidine/DMF for 75 minutes and then washed with DMF.

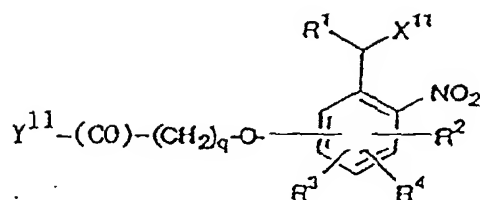
[0139] To a suspension of the deprotected photolinker (35 mg) in trimethyl orthoformate (1 mL) was added t-butyl glyoxalate (50 mg). The reaction was heated at 70°C for 3 hours with frequent shaking. The reaction mixture was cooled, filtered, washed, and dried to yield the corresponding imine.

[0140] The 3-phthalimido-2-azetidinone was prepared by treating the imine with phthalimido acetyl chloride (25 equivalents) and triethylamine (30 equivalents) at 0°C. The resin was transferred into a centrifuge filter unit, washed (4 x 2 mL methylene chloride, 2 x 2 mL methanol, 3 x 2 mL diethyl ether) and dried under high vacuum for 30 minutes.

[0141] The β-lactam was cleaved from the resin through photolysis in ethanol or DMSO using a 500 W Hg ARC lamp fitted with a 350-450 nm dichroic mirror at a 10 mW/cm² power level measured at 365 nm. After photolysis, the samples were filtered and the filtrate was collected. The samples were analyzed by HPLC, mass spectroscopy and NMR and the data indicated that the desired β-lactam was produced in high purity. This reaction sequence is shown schematically in Figure 5.

Claims

1. The use of a compound having the formula:

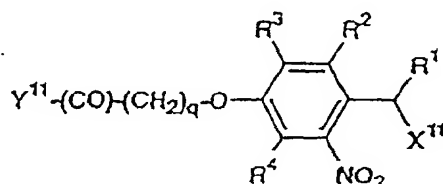


wherein

R¹ is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl, C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of halogen, -SH, -SP, -OH, -OP, -NH₂, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 10, as a photochemically cleavable linking group.

2. A use as claimed in claim 1 wherein q is an integer of from 1 to 4.

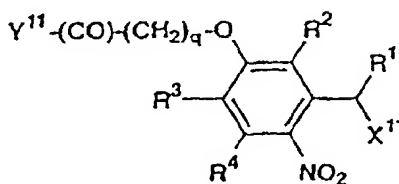
3. A use as claimed in claim 1 wherein the compounds has the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4.

4. A use as claimed in claim 1 wherein the compound has the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ and Y¹¹ are each independently selected from the group consisting of -Br, -Cl, -OH, -NH₂, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4.

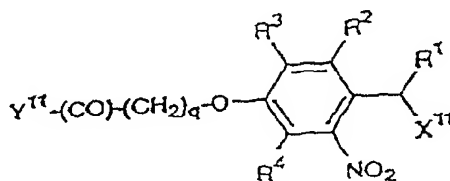
5. A use as claimed in claim 3 or claim 4,

wherein R¹ is methyl, R² and R⁴ are both hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, -OH, -O (CO) Cl, -OCH₂Cl, -O (CO) OAr, -OAc, -NH₂, -ODMT, -NHBOC -NHAc, or -NHFmoc.

6. A use as claimed in claim 1

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -Br, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OH, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OH, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OAc, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OAc, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NH₂, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 3;
 wherein R³, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —O(CO)Cl, and q is 3;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 1;
 wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OCH₂Cl, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —Br, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OH, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —OAc, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NH₂, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NAC, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is —OH, and X¹¹ is —NHFmoc, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -NHFmoc, and q is 3;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -O(CO)Cl, and q is 1;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -O(CO)Cl, and q is ;
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OCH₂Cl, and q is 1; or
 wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, Y¹¹ is -OH, and X¹¹ is -OCH₂Cl, and q is 3.

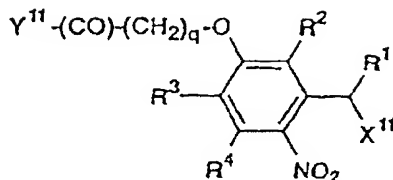
7. A compound having the formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X¹¹ is selected from the group consisting of -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OP, -NHP, in which P is suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of hydrogen, unsubstituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; Y¹¹ is selected from the group consisting of -Br, -Cl, -OH, -O(CO) Cl, -OCH₂Cl, -O(CO)OAr, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R⁵ and R⁶ are independently selected from the group consisting of heteroaryl and substituted heteroaryl; and q is integer of from 1 to 4.

8. A compound having the formula:



wherein

R^1 is hydrogen, C_1 - C_8 alkyl; R^2 and R^4 are each independently hydrogen, C_1 - C_8 alkyl or C_1 - C_8 alkoxy; R^3 is C_1 - C_8 alkoxy; X^{11} is selected from the group consisting of -Br, -Cl, -OH, -NH₂, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R^5 and R^6 are independently selected from the group consisting of hydrogen, unsubstituted alkyl, aryl, substituted aryl, aryl alkyl, substituted aryl alkyl, heteroaryl, and substituted heteroaryl; Y^{11} is selected from the group consisting of -Br, -Cl, -OH, -OP, -NHP, in which P is a suitable protecting or activating group, and -NR⁵R⁶ wherein R^5 and R^6 are independently selected from the group consisting of heteroaryl, and substituted heteroaryl; and q is an integer of from 1 to 4.

9. A compound as claimed in claim 7 or claim 8,

wherein R^1 is methyl, R^2 and R^4 are both hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -Br, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBOC-NHAc, or -NHFmoc.

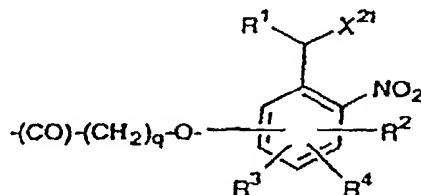
10. A compound as claimed in claim 6 or claim 7

wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -Br, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -Br, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OH, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OH, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OAc, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OAc, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NH₂, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NH₂, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NAC, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NAC, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NHFmoc, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NHFmoc, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -O(CO)Cl, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -O(CO)Cl, and q is 3;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OCH₂Cl, and q is 1;
 wherein R^1 , R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OCH₂Cl, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -Br, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -Br, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OH, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OH, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OAc, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OAc, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NH₂, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NH₂, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NAC, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NAC, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NHFmoc, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -NHFmoc, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -O(CO)Cl, and q is 1;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -O(CO)Cl, and q is 3;
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OCH₂Cl, and q is 1; or
 wherein R^1 is methyl, R^2 and R^4 are hydrogen, R^3 is methoxy, Y^{11} is -OH, and X^{11} is -OCH₂Cl, and q is 3.

11. A composition having the formula:

A-B-L

wherein A is a solid substrate, B is a bond or a derivatizing group, and L is a photocleavable linking group having the formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl, aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl, or C₁-C₈ alkoxy; X²¹ is halogen, -SH, -SP, -OH, -NH₂, -OP or -NHP, wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 10.

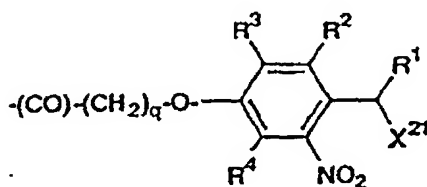
12. A composition of claim 11, wherein the derivatizing group comprises an amino acid, peptide, or polyether chain having an amine functionality at the termini.

13. A composition of claim 12, wherein the derivatizing group is selected from the group consisting of a valence bond, -NH-(CH₂CH₂O)_nCH₂CH₂NH-, -NH-CH₂(CH₂CH₂O)_nCH₂CH₂CH₂NH-, -NH-CH₂(CH₂CH₂CH₂O)_nCH₂CH₂CH₂NH- or -NH-CH₂(CH₂O)_m(CH₂)_nO(CH₂)_mNH-, in which n is an integer of from 1 to 10 and m is an integer of from 1 to 6.

14. A composition of claim 13, wherein the derivatizing group is -NH-(CH₂CH₂O)₂CH₂CH₂NH-.

15. A composition of any one of claims 11 to 14, wherein either:

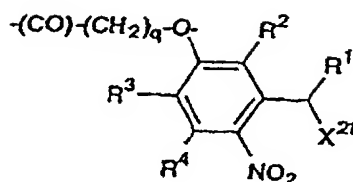
(a) L has the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy, X²¹ is -Br, -Cl, -OH, -OF, -SH, -SP, -NH₂ or -NHP, wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 4; or

(b) L has the formula:



wherein

R¹ is hydrogen, C₁-C₈ alkyl; R² and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; R³ is C₁-C₈ alkoxy; X²¹ is -Br, -Cl, -OH, -OP, -SH, -SP, -NH₂ or -NHP, wherein P is a suitable protecting or activating group; and q is an integer of from 1 to 4.

16. A composition of claim 15, wherein R¹ is methyl and R³ is methoxy.

17. A composition of claim 16, wherein R² and R⁴ are each hydrogen.

18. A composition of any one of claims 16 or 17, wherein n is 3, R¹ is methyl, R³ is methoxy, R² and R⁴ are each hydrogen, and X²¹ is -OH, -ODMT, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH-Fmoc, -NHAc, or -NH-BOC. e. g., a composition

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH-Fmoc, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH-Fmoc, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 3;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 1;

wherein R¹, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -Br, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OH, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OAc, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH₂, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NAC, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH-Fmoc, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -NH-Fmoc, and q is 3;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 1;

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -O(CO)Cl, and q is 3;

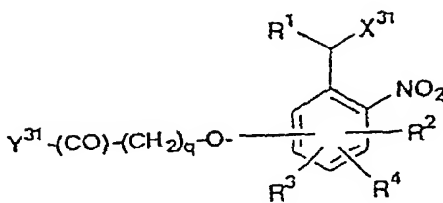
wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 1; or

wherein R¹ is methyl, R² and R⁴ are hydrogen, R³ is methoxy, and X¹¹ is -OCH₂Cl, and q is 3.

19. A method of synthesizing small ligand molecules or peptides on a solid support having optional spacers, said small ligand molecules or peptides being removable therefrom upon application of a suitable energy source, said method

comprising the steps of:

(a) providing on the surface of said solid support, a photolabile linking group of formula:



wherein,

R¹ is hydrogen, C₁-C₈ alkyl aryl or arylalkyl; R², R³ and R⁴ are each independently hydrogen, C₁-C₈ alkyl or C₁-C₈ alkoxy; X³¹ is halogen, —OH, —OP, —SH, —SP, —NH₂ or —NHP and Y³¹ is Br, Cl, OH, NH₂, SH, OP, SP and NHP, wherein P is a protecting or activating group; and q is an integer of from 1 to 10, to produce a derivatized solid support having attached photolabile linking groups suitably protected with protecting groups;

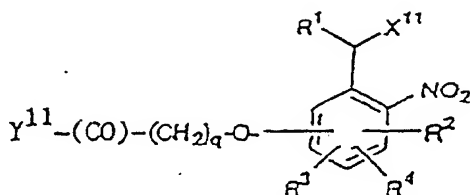
(b) optionally removing said protecting groups from said derivatized solid support to provide a derivatized solid support having photolabile linking groups with synthesis initiation sites;

(c) optionally activating said solid support to provide a derivatized solid support having photolabile linking groups with activated synthesis sites; and

(d) coupling a first building block to said synthesis initiation sites on said derivatized solid support to produce a solid support having attached building block which is removable therefrom upon application of said energy source.

Patentansprüche

1. Verwendung einer Verbindung mit der Formel:

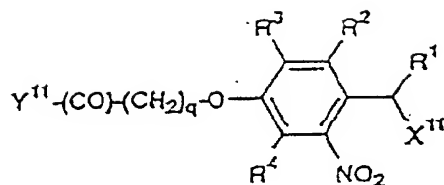


worin

R¹ Wasserstoff, C₁-C₈-Alkyl, Aryl oder Arylalkyl ist; R², R³ und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl, C₁-C₈-Alkoxy sind; X¹¹ und Y¹¹ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Halogen, —SH, —SP, —OH, —OP, —NH₂, —NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und —NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, Alkyl, substituiertem Alkyl, Aryl, substituiertem Aryl, Arylalkyl, substituiertem Arylalkyl, Heteroaryl und substituiertem Heteroaryl; und q eine ganze Zahl von 1 bis 10.4 ist, als eine photochemisch spaltbare Bindungsgruppe.

2. Verwendung nach Anspruch 1, worin q eine ganze Zahl von 1 bis 4 ist.

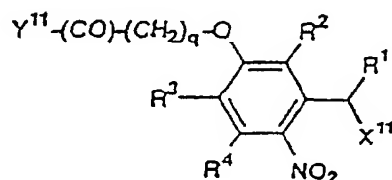
3. Verwendung nach Anspruch 1, worin die Verbindungen die Formel:



besitzen, worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy sind, R³ C₁-C₈-Alkoxy ist; X¹¹ und Y¹¹ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OP, -NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, Alkyl, substituiertem Alkyl, Aryl, substituiertem Aryl, Arylalkyl, substituiertem Arylalkyl, Heteroaryl und substituiertem Heteroaryl; und q eine ganze Zahl von 1 bis 4 ist.

4. Verwendung nach Anspruch 1, worin die Verbindung die Formel besitzt:



worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy sind; R³ C₁-C₈-Alkoxy ist; X¹¹ und Y¹¹ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus -Br, -Cl, -OH, -NH₂, -OP, -NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, Alkyl, substituiertem Alkyl, Aryl, substituiertem Aryl, Arylalkyl, substituiertem Arylalkyl, Heteroaryl und substituiertem Heteroaryl; und q eine ganze Zahl von 1 bis 4 ist.

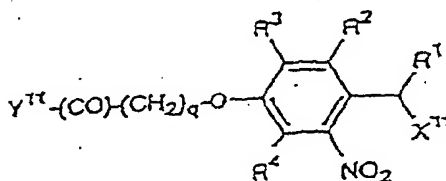
5. Verwendung nach Anspruch 3 oder Anspruch 4, worin R¹ Methyl ist, R² und R⁴ jeweils Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist, X¹¹ -Br, -OH -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBoc, -NHAc oder -NHfmoc ist.

6. Verwendung nach Anspruch 1,

worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Br ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Br ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OH ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OH ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OAc ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OAc ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NH₂ ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NH₂ ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Nac ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Nac ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NHfmoc ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NHfmoc ist und q 3 ist;

worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -O(CO)Cl ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -O(CO)Cl ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OCH₂Cl ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OCH₂Cl ist und q 3 ist;
 5 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Br ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Br ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OH ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OH ist und q 3 ist;
 10 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OAc ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OAc ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NH₂ ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NH₂ ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Nac ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -Nac ist und q 3 ist;
 15 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NHFmoc ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -NHFmoc ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -O(CO)Cl ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -O(CO)Cl ist und q 3 ist;
 20 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OCH₂Cl ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y¹¹ -OH ist und X¹¹ -OCH₂Cl ist und q 3 ist.

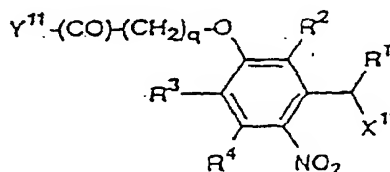
7. Verbindung mit der Formel:



worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy
 sind, R³ C₁-C₈-Alkoxy ist; X¹¹ ausgewählt ist aus der Gruppe bestehend aus -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl,
 -O(CO)OAr, -NH₂, -OP, -NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶,
 worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, nicht substitu-
 iertem Alkyl, Aryl, substituiertem Aryl, Arylalkyl, substituiertem Arylalkyl, Heteroaryl und substituiertem Heteroaryl;
 Y¹¹ ausgewählt ist aus der Gruppe bestehend aus -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OP, -NHP, worin
 40 P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig
 ausgewählt sind aus der Gruppe bestehend aus Heteroaryl und substituiertem Heteroaryl; und q eine ganze Zahl
 von 1 bis 4 ist.

8. Verbindung mit der Formel:



worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy

sind, R^3 C_1 - C_8 -Alkoxy ist; X^{11} ausgewählt ist aus der Gruppe bestehend aus -Br, -Cl, -OH, -NH₂, -OP, -NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Wasserstoff, nicht substituiertem Alkyl, Aryl, substituiertem Aryl, Arylalkyl, substituiertem Arylalkyl, Heteroaryl und substituiertem Heteroaryl; Y^{11} ausgewählt ist aus der Gruppe bestehend aus -Br, -Cl, -OH, -OP, -NHP, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist, und -NR⁵R⁶, worin R⁵ und R⁶ jeweils unabhängig ausgewählt sind aus der Gruppe bestehend aus Heteroaryl und substituiertem Heteroaryl; und q eine ganze Zahl von 1 bis 4 ist.

9. Verbindung nach Anspruch 7 oder Anspruch 8,

worin R¹ Methyl ist; R² und R⁴ jeweils Wasserstoff sind, R³ Methoxy ist; Y^{11} -OH ist und X^{11} -Br, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBOC, -NHAc oder -NHFmoc ist.

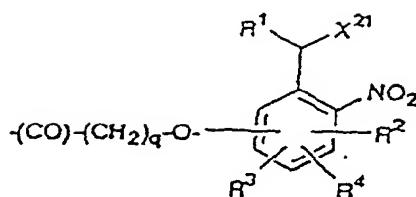
10. Verbindung nach Anspruch 6 oder Anspruch 7,

worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -Br ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -Br ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OH ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OH ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OAc ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OAc ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NH₂ ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NH₂ ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NAc ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NAc ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NHFmoc ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NHFmoc ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -O(CO)Cl ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -O(CO)Cl ist und q 3 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OCH₂Cl ist und q 1 ist;
 worin R¹, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OCH₂Cl ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -Br ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -Br ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OH ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OH ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OAc ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OAc ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NH₂ ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NH₂ ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NAc ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NAc ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NHFmoc ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -NHFmoc ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -O(CO)Cl ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -O(CO)Cl ist und q 3 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OCH₂Cl ist und q 1 ist;
 worin R¹ Methyl ist, R² und R⁴ Wasserstoff sind, R³ Methoxy ist, Y^{11} -OH ist und X^{11} -OCH₂Cl ist und q 3 ist.

11. Zusammensetzung mit der Formel:

A-B-L

worin A ein festes Substrat ist, B eine Bindung oder eine derivatisierende Gruppe ist und L eine photospaltbare Bindungsgruppe mit der Formel:



ist, worin

R¹ Wasserstoff, C₁-C₈-Alkyl, Aryl oder Arylalkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy sind, X²¹ Halogen, -SH, -SP, -OH, -NH₂, -OP oder -NHP ist, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist; und q eine ganze Zahl von 1 bis 10 ist.

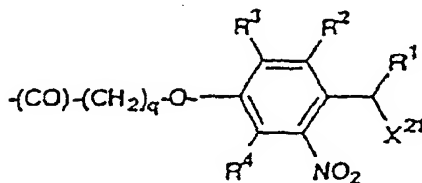
12. Zusammensetzung nach Anspruch 11, worin die derivatisierende Gruppe eine Aminosäure, ein Peptid oder eine Polyetherkette mit einer Aminfunktionalität an den Enden umfasst.

13. Zusammensetzung nach Anspruch 12, worin die derivatisierende Gruppe ausgewählt ist aus der Gruppe bestehend aus einer Valenzbindung, -NH-(CH₂CH₂O)_nCH₂CH₂NH-, -NH-CH₂-(CH₂CH₂O)_nCH₂CH₂CH₂NH-, -NH-CH₂-(CH₂CH₂CH₂O)_nCH₂CH₂CH₂NH- oder -NH-(CH₂)_mO(CH₂)_nO(CH₂)_mNH-, worin n eine ganze Zahl von 1 bis 10 ist und m eine ganze Zahl von 1 bis 6 ist.

14. Zusammensetzung nach Anspruch 13, worin die derivatisierende Gruppe -NH-(CH₂CH₂O)₂CH₂CH₂NH- ist.

15. Zusammensetzung nach einem der Ansprüche 11 bis 14, worin entweder

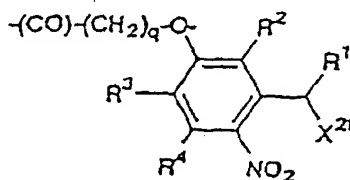
(a) L die Formel:



besitzt, worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-Alkoxy sind; R³ C₁-C₈-Alkoxy ist, X²¹ -Br, -Cl, -OH, -OP, -SH, -SP, -NH₂ oder -NHP ist, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist; und q eine ganze Zahl von 1 bis 4 ist; oder

(b) L die Formel:



besitzt, worin

R¹ Wasserstoff, C₁-C₈-Alkyl ist; R² und R⁴ jeweils unabhängig Wasserstoff, C₁-C₈-Alkyl oder C₁-C₈-

Alkoxy sind; R^3 C_1 - C_8 -Alkoxy ist, X^{21} -Br, -Cl, -OH, -OP, -SH, -SP, -NH₂ oder -NHP ist, worin P eine geeignete Schutzgruppe oder Aktivierungsgruppe ist; und q eine ganze Zahl von 1 bis 4 ist.

16. Zusammensetzung nach Anspruch 15, worin R^1 Methyl ist und R^3 Methoxy ist.

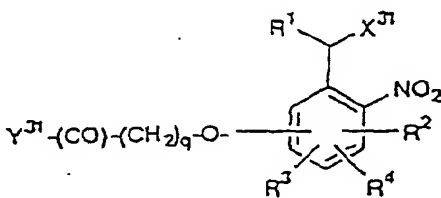
17. Zusammensetzung nach Anspruch 16, worin R^2 und R^4 jeweils Wasserstoff sind.

18. Zusammensetzung nach einem der Ansprüche 16 oder 17, worin n 3 ist, R^1 Methyl ist, R^3 Methoxy ist, R^2 und R^4 jeweils Wasserstoff sind, und X^{21} -OH, -ODMT, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH-Fmoc, -NHAc oder -NH-BOC ist, z. B. eine Zusammensetzung,

worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -Br ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -Br ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OH ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OH ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OAc ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OAc ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NH₂ ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NH₂ ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NAC ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NAC ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NHFmoc ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NHFmoc ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -O(CO)Cl ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -O(CO)Cl ist und q 3 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OCH₂Cl ist und q 1 ist;
 worin R^1 , R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OCH₂Cl ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -Br ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -Br ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OH ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OH ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OAc ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OAc ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NH₂ ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NH₂ ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NAC ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NAC ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NHFmoc ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -NHFmoc ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -O(CO)Cl ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -O(CO)Cl ist und q 3 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OCH₂Cl ist und q 1 ist;
 worin R^1 Methyl ist, R^2 und R^4 Wasserstoff sind, R^3 Methoxy ist, und X^{11} -OCH₂Cl ist und q 3 ist.

19. Verfahren zum Synthetisieren von kleinen Ligandenmolekülen oder Peptiden auf einem Trägermaterial, gegebenenfalls mit Spacern, wobei die kleinen Ligandenmoleküle oder Peptide nach Applikation einer geeigneten Energiequelle davon entfernbare sind, wobei das Verfahren die Schritte umfasst:

(a) Bereitstellen einer photolabilen Bindungsgruppe mit der Formel:



auf der Oberfläche des Trägermaterials, worin

R^1 Wasserstoff, C_1 - C_8 -Alkyl, Aryl oder Arylalkyl ist; R^2 , R^3 und R^4 jeweils unabhängig Wasserstoff, C_1 - C_8 -Alkyl oder C_1 - C_8 -Alkoxy sind; X^{11} Halogen, -OH, -OP, -SH, -SP, -NH₂ oder -NHP ist; Y^{11} -Br, -Cl, -OH, -NH₂, -SH, -OP, -SP und -NHP ist, worin P eine Schutzgruppe oder Aktivierungsgruppe ist; und q eine ganze Zahl von 1 bis 10 ist, zur Herstellung eines derivatisierten Trägermaterials mit angehefteten photolabilen Bindungsgruppen, entsprechend geschützt mit Schutzgruppen;

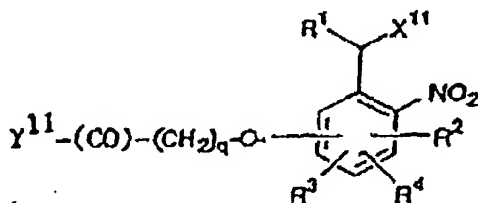
(b) gegebenenfalls Entfernen der Schutzgruppen von dem derivatisierten Trägermaterial, um ein derivatisiertes Trägermaterial mit photolabilen Bindungsgruppen mit Synthesestartstellen bereitzustellen;

(c) gegebenenfalls Aktivieren des Trägermaterials, um ein derivatisiertes Trägermaterial mit photolabilen Bindungsgruppen mit aktivierten Synthesestellen bereitzustellen; und

(d) Kopplung eines ersten Bausteins an die Synthesestartstellen auf dem derivatisierten Trägermaterial, um ein Trägermaterial mit einem angehefteten Baustein zu erzeugen, welcher nach Applikation der Energiequelle davon entfernbar ist.

Revendications

1. Utilisation d'un composé ayant la formule suivante :

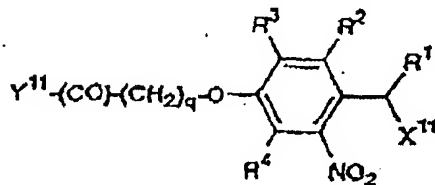


dans laquelle

R^1 est un hydrogène, un alkyle en C_1 à C_8 , un aryle ou arylealkyle ; R^2 , R^3 et R^4 sont chacun indépendamment un hydrogène, un alkyle en C_1 à C_8 , un alkoxy en C_1 à C_8 ; X^{11} et Y^{11} sont chacun indépendamment choisis dans le groupe composé d'halogène, -SH, -SP, -OH, -OP, -NH₂, -NHP, dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hydrogène, alkyle, alkyle substitué, aryle, aryle substitué, aryle alkyle, aryle alkyle substitué, hétéroaryle, et hétéroaryle substitué, et q est un nombre entier de 1 à 10, comme groupe de liaison photochimiquement clivable.

2. Utilisation selon la revendication 1, dans laquelle q est un nombre entier de 1 à 4.

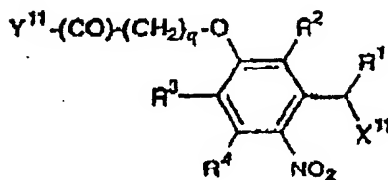
3. Utilisation selon la revendication 1, dans laquelle le composé a la formule suivante :



dans laquelle

R^1 est un hydrogène, un alkyle en C_1 à C_8 , R^2 et R^4 sont chacun indépendamment un hydrogène, un alkyle en C_1 à C_8 ou un alkoxy en C_1 à C_8 , R^3 est un alkoxy en C_1 à C_8 , X^{11} et Y^{11} sont chacun indépendamment choisis dans le groupe composé de -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OP, -NHP, dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hydrogène, d'alkyle, d'alkyle substitué, d'aryle, d'aryle substitué, d'aryle alkyle, d'aryle alkyle substitué, d'hétéroaryle, et d'hétéroaryle substitué, et q est un nombre entier de 1 à 4.

4. Utilisation selon la revendication 1, dans laquelle le composé à la formule suivante .



dans laquelle

R¹ est un hydrogène, un alkyle en C₁ à C₈ ; R² et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈ ou un alkoxy en C₁ à C₈, R³ est un alkoxy en C₁ à C₈, X¹¹ et Y¹¹ sont chacun indépendamment choisis dans le groupe composé de -Br, -Cl, -OH, -NH₂, -OP, -NHP dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hydrogène, d'alkyle, d'alkyle substitué, d'aryle, d'aryle substitué, d'aryle alkyle, d'aryle alkyle substitué, d'hétéroaryle, et d'hétéroaryle substitué ; et q est un nombre entier de 1 à 4.

5. Utilisation selon la revendication 3 ou 4, dans laquelle R¹ est un méthyle, R² et R⁴ sont tous deux un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBOC -NHAc ou -NHFmoc
6. Utilisation selon la revendication 1, dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAC, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAC, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHFmoc, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHFmoc, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl, et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl, et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl, et q est égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br, et q est égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est

un -Br, et q est égal à 3 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH, et q est égal à 3 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc, et q est égal à 3 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂, et q est égal à 3 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAC, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAC, et q est égal à 3 ;

dans laquelle R¹ est un méthylé, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHfmoc, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHfmoc, et q est égal à 3 ;

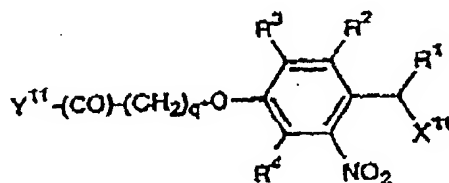
dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl, et q est égal à 1 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl, et q est égal à 3 ;

dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl, et q est égal à 1 ; ou

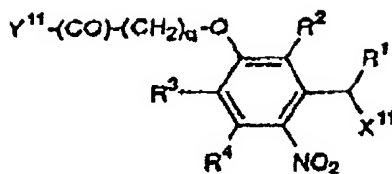
dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl, et q est égal à 3 ;

7. Composé ayant la formule suivante :



dans laquelle R¹ est un hydrogène, un alkyle en C₁ à C₈ ; R² et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈ ou un alkoxy en C₁ à C₈ ; R³ est un alkoxy en C₁ à C₈, X¹¹ est choisi dans le groupe composé de -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -NH₂, -OP, -NHP dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hydrogène, d'alkyle non substitué, d'aryle, d'aryle substitué, d'aryle alkyle, d'aryle alkyle substitué, d'hétéroaryle, et d'hétéroaryle substitué, Y¹¹ est choisi dans le groupe composé de -Br, -Cl, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OP, -NHP dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont chacun indépendamment choisis dans le groupe composé d'hétéroaryle et d'hétéroaryle substitué, et q est un nombre entier d'1 à 4.

8. Composé ayant la formule suivante :



dans lequel R¹ est un hydrogène, un alkyle en C₁ à C₈ ; R² et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈, ou un alkoxy en C₁ à C₈ ; R³ est un alkoxy en C₁ à C₈ ; X¹¹ est choisi dans le groupe composé de -Br, -Cl, -OH, -NH₂, -OP, -NHP dans lequel P est un groupe de protection ou d'activation adapté, et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hydrogène, d'alkyle non substitué, d'aryle, d'aryle substitué, d'aryle alkyle, d'aryle alkyle substitué, d'hétéroaryle, et d'hétéroaryle substitué ; Y¹¹ est choisi dans le groupe composé de -Br, -Cl, -OH, -OP, -NHP dans lequel P est un groupe de protection ou d'activation adapté et -NR⁵R⁶ dans lequel R⁵ et R⁶ sont indépendamment choisis dans le groupe composé d'hétéroaryle, et d'hétéroaryle substitué ; et q est un nombre entier de 1 à 4.

9. Composé selon la revendication 7 ou la revendication 8, dans lequel R¹ est un méthyle, R² et R⁴ sont tous deux un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br, -OH, -O(CO)Cl, -OCH₂Cl, -O(CO)OAr, -OAc, -NH₂, -ODMT, -NHBOC, -NHAc ou -NHFmoc.

10. Composé selon la revendication 6 ou 7

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂ et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂ et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAc et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NAc et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHFmoc et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHFmoc et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl et q est égal à 3 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl et q est égal à 1 ;

dans lequel R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Br et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est

un -Br et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OH et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OAc et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂ et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NH₂ et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Nac et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -Nac et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHfmoc et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -NHfmoc et q est égal à 3 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -O(CO)Cl et q est égal à 3 ;

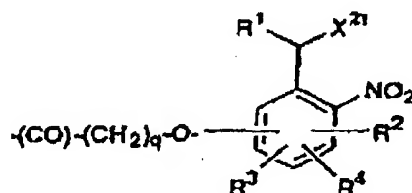
dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl et q est égal à 1 ;

dans lequel R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy, Y¹¹ est un -OH, et X¹¹ est un -OCH₂Cl et q est égal à 3 ;

11. Composition ayant la formule :

A-B-L

dans laquelle A est un substrat solide, B est une liaison ou un groupe de dérivation, et L est un groupe de liaison photo-clivable ayant la formule suivante :



dans laquelle

R¹ est un hydrogène, un alkyle en C₁ à C₈, un aryle ou arylalkyle ; R², R³ et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈, ou un alkoxy en C₁ à C₈ ; X²¹ est un halogène, -SH, -SP, -OH, -NH₂, -OP ou -NHP, dans lequel P est un groupe de protection ou d'activation adapté, et q est un nombre entier de 1 à 10.

12. Composition selon la revendication 11, dans laquelle le groupe de dérivation comprend un acide aminé, un peptide, ou une chaîne de polyéther ayant une fonctionnalité d'amine aux extrémités.

13. Composition selon la revendication 12, dans laquelle le groupe de dérivation est choisi dans le groupe composé

d'une liaison de valence,

-NH-(CH₂CH₂O)_nCH₂CH₂NH-,

-NH-CH₂(CH₂CH₂O)_nCH₂CH₂CH₂NH-,

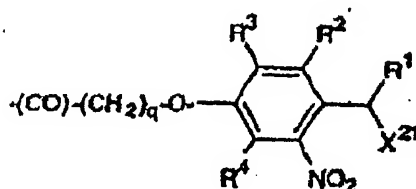
-NH-CH₂(CH₂CH₂CH₂O)_nCH₂CH₂CH₂NH- ou

NH-(CH₂)_mO(CH₂)_nO(CH₂)_mNH-, dans lequel n est un nombre entier de 1 à 10, et m est un nombre entier de 1 à 6.

14. Composition selon la revendication 13, dans laquelle le groupe de dérivation est un -NH-(CH₂CH₂O)₂CH₂CH₂NH-

15. Composition selon l'une quelconque des revendications 11 à 14 dans laquelle

(a) L a la formule suivante :

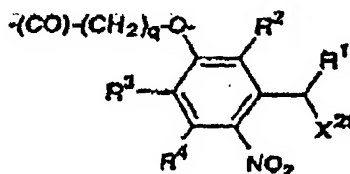


dans laquelle

R¹ est un hydrogène, un alkyle en C₁ à C₈ ; R² et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈ ou un alkoxy en C₁ à C₈ ; R³ est un alkoxy en C₁ à C₈, X²¹ est un -Br, -Cl, -OH, -OP, -SH, -SP, -NH₂ ou -NHP,

dans lequel P est un groupe de protection ou d'activation ; et q est un nombre entier de 1 à 4 ; ou

(b) L a la formule suivante :



dans laquelle R¹ est un hydrogène, un alkyle en C₁ à C₈, R² et R⁴ sont chacun indépendamment un hydrogène, un alkyle en C₁ à C₈ ou un alkoxy en C₁ à C₈ ; R³ est un alkoxy en C₁ à C₈, X²¹ est un -Br, -Cl, -OH, -SH, -SP, -NH₂ ou -NHP, dans lequel P est un groupe de protection ou d'activation ; et q est un nombre entier de 1 à 4.

16. Composition selon la revendication 15, dans laquelle R¹ est un méthyle et R³ est un méthoxy.

17. Composition selon la revendication 16, dans laquelle R² et R⁴ sont chacun un hydrogène.

18. Composition selon l'une quelconque des revendications 16 ou 17, dans laquelle n est égal à 3, R¹ est un méthyle, R³ est un méthoxy, R² et R⁴ sont chacun un hydrogène et X²¹ est un -OH, -ODMT, -O(CO)Cl, -OCH₂Cl, -O-CO-OAr, -OAc, -NH-Fmoc, -NHAc ou -NH-Boc, par exemple une composition

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -Br et q est égal à 1 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -Br et q est égal à 3 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -OH et q est égal à 1 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un —OH et q est égal à 3 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -OAc et q est égal à 1 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -OAc et q est égal à 3 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -NH₂ et q est égal à 1 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -NH₂ et q est égal à 3 ;

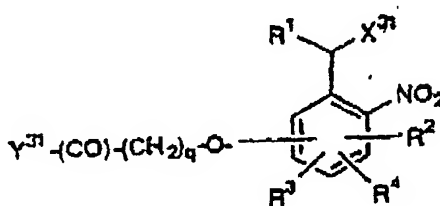
dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -Nac et q est égal à 1 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -Nac et q est égal à 3 ;

dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -NHFmoc et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -NHFmoc et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -O(CO)Cl et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -O(CO)Cl et q est égal à 3 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -OCH₂Cl et q est égal à 1 ;
 dans laquelle R¹, R² et R⁴ sont un hydrogène, R³ est un méthoxy, et X¹¹ est un -OCH₂Cl et q est égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -Br et q est
 égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -Br et q est
 égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OH et q est
 égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OH et q est
 égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OAc et q est
 égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OAc et q est
 égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NH₂ et q est
 égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NH₂ et q est
 égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NAC et q est
 égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NAC et q est
 égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NHFmoc et
 q est égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -NHFmoc et
 q est égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -O(CO)Cl et
 q est égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -O(CO)Cl et
 q est égal à 3 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OCH₂Cl et
 q est égal à 1 ;
 dans laquelle R¹ est un méthyle, R² et R⁴ sont un hydrogène, R³ est un méthoxy et X¹¹ est un -OCH₂Cl et
 q est égal à 3 ;

19. Procédé de synthèse de petites molécules de groupes de coordination ou peptides sur un support solide ayant des espaceurs en option, lesdites petites molécules de ligands ou peptides pouvant être retirées de ceux-ci lors un application d'une source d'énergie adaptée, ledit procédé comprenant les étapes :

(a) apporter, sur la surface dudit support solide, un groupe de liaison photolabile ayant la formule suivante :



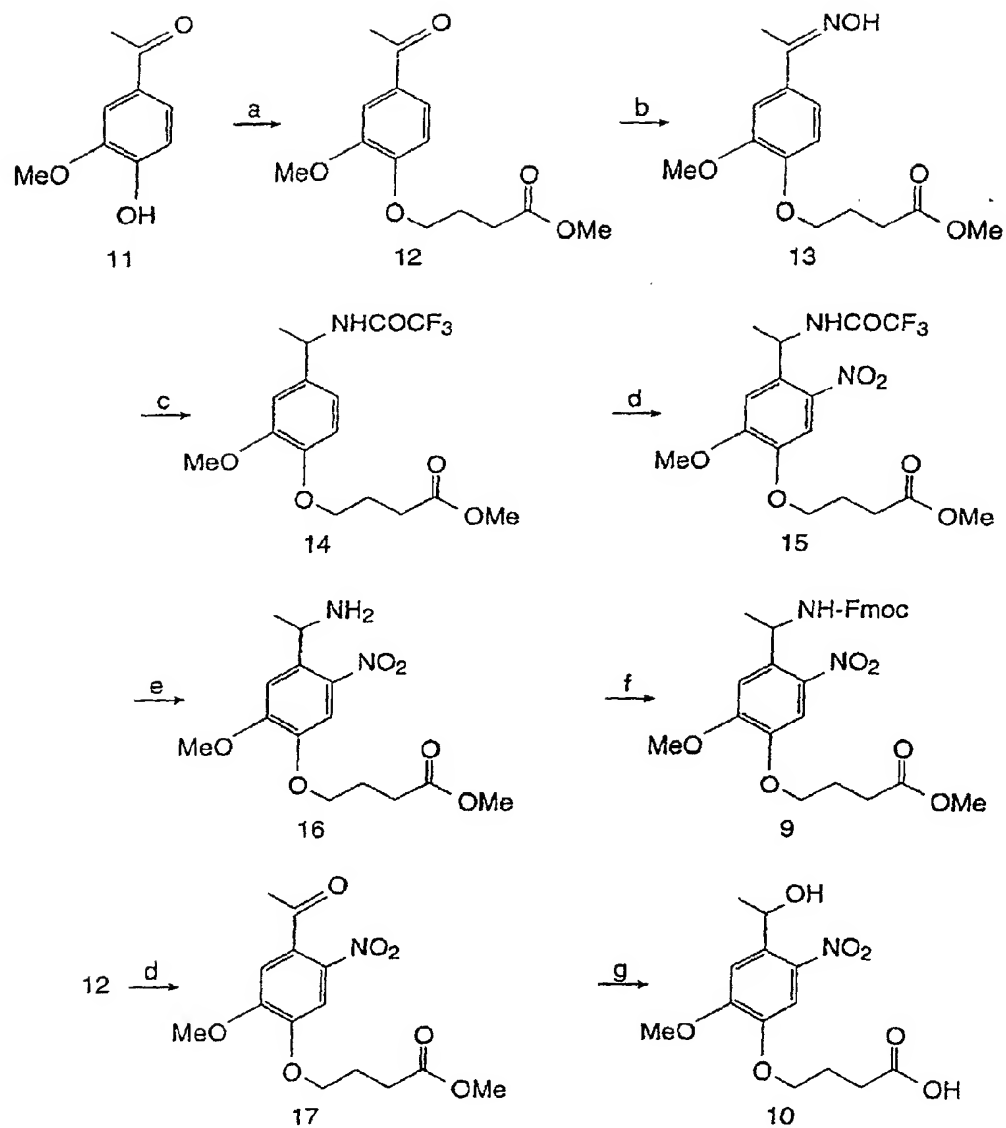
dans laquelle
 R¹ est un hydrogène, un alkyle en C₁ à C₈, un aryle

ou arylalkyle ; R^2 , R^3 et R^4 sont chacun indépendamment un hydrogène, un alkyle en C_1 à C_8 ou un alkoxy en C_1 à C_8 ; X^{31} est un halogène, -OH, -OP, -SH, -SP, -NH₂ ou -NHP et Y^{31} est un Br, Cl, OH, NH₂, SH, OP, SP et NHP, dans lequel P est un groupe de protection ou d'activation ; et q est un nombre entier de 1 à 10, pour produire un support solide dérivé ayant des groupes de liaison photolabiles fixés, convenablement protégés avec les groupes de protection ;

(b) éventuellement éliminer lesdits groupes de protection dudit support solide dérivé pour fournir un support solide dérivé ayant des groupes de liaison photolabiles avec des sites d'initiation de synthèse ;

(c) éventuellement activer ledit support solide pour fournir un support solide dérivé ayant des groupes de liaison photolabiles avec des sites de synthèse activés ; et

(d) coupler un premier bloc de construction auxdits sites initiateur de synthèse sur ledit support solide dérivé pour produire un support solide ayant un bloc de construction fixé pouvant être enlevé lors d'une application de ladite source d'énergie.



(a) $\text{Br}(\text{CH}_2)_3\text{CO}_2\text{Me}$, K_2CO_3 , DMF; (b) $\text{NH}_2\text{OH}\cdot\text{HCl}$, pyridine;
 (c) (i) H_2 , Pd/C; (ii) TFAA, pyridine; (d) HNO_3 , NaOH,
 MeOH; Fmoc-Cl, NaHCO_3 ; (g) (i) NaBH₄, MeOH; (ii) NaOH.

FIG. 1

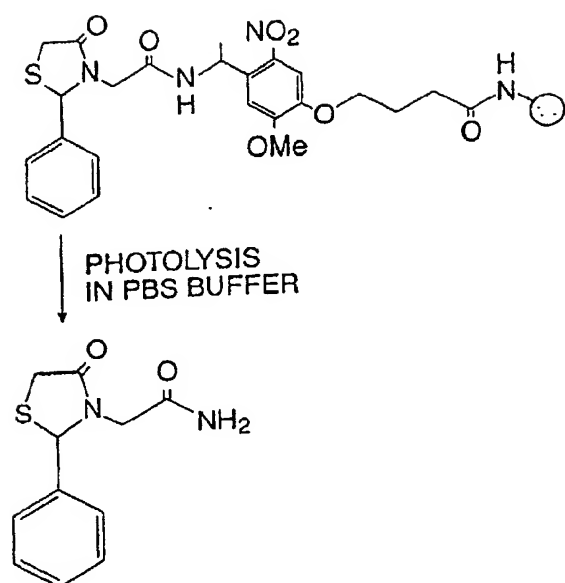


FIG. 2A

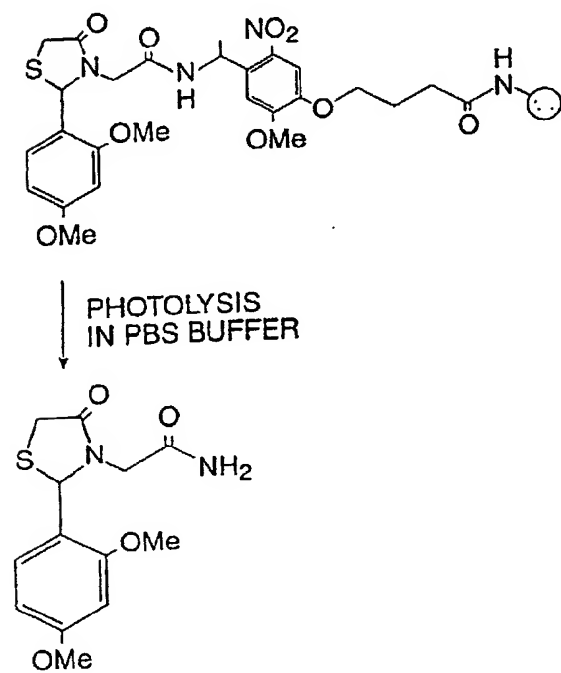


FIG. 2B

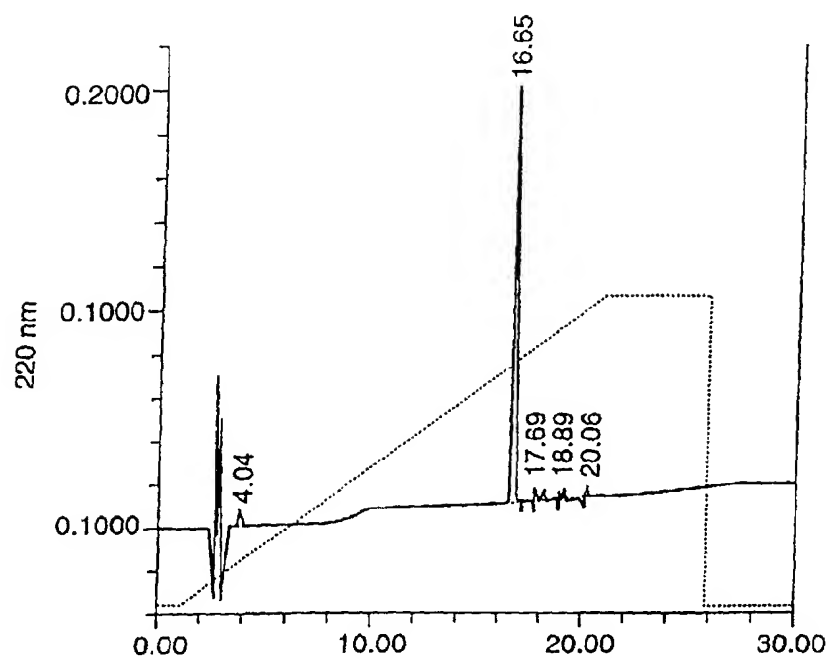


FIG. 2C

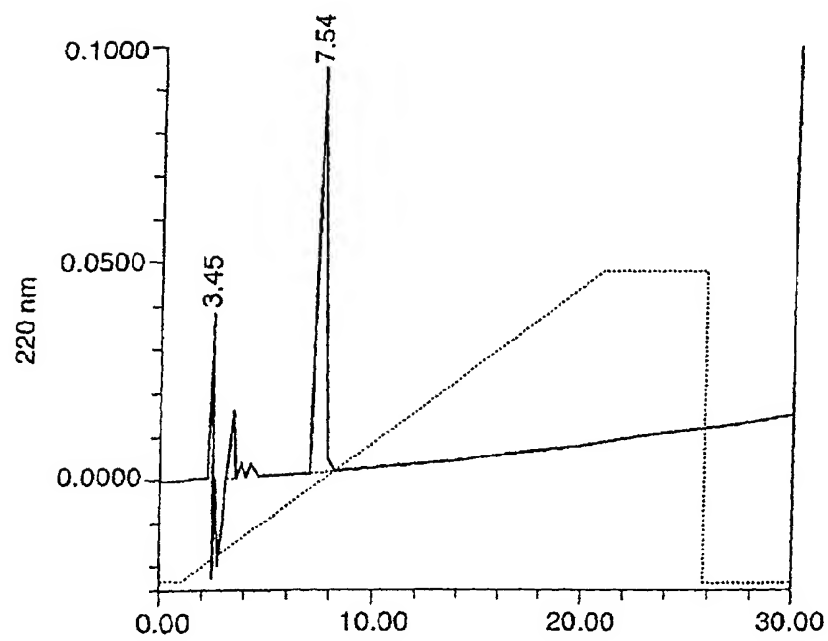


FIG. 2D

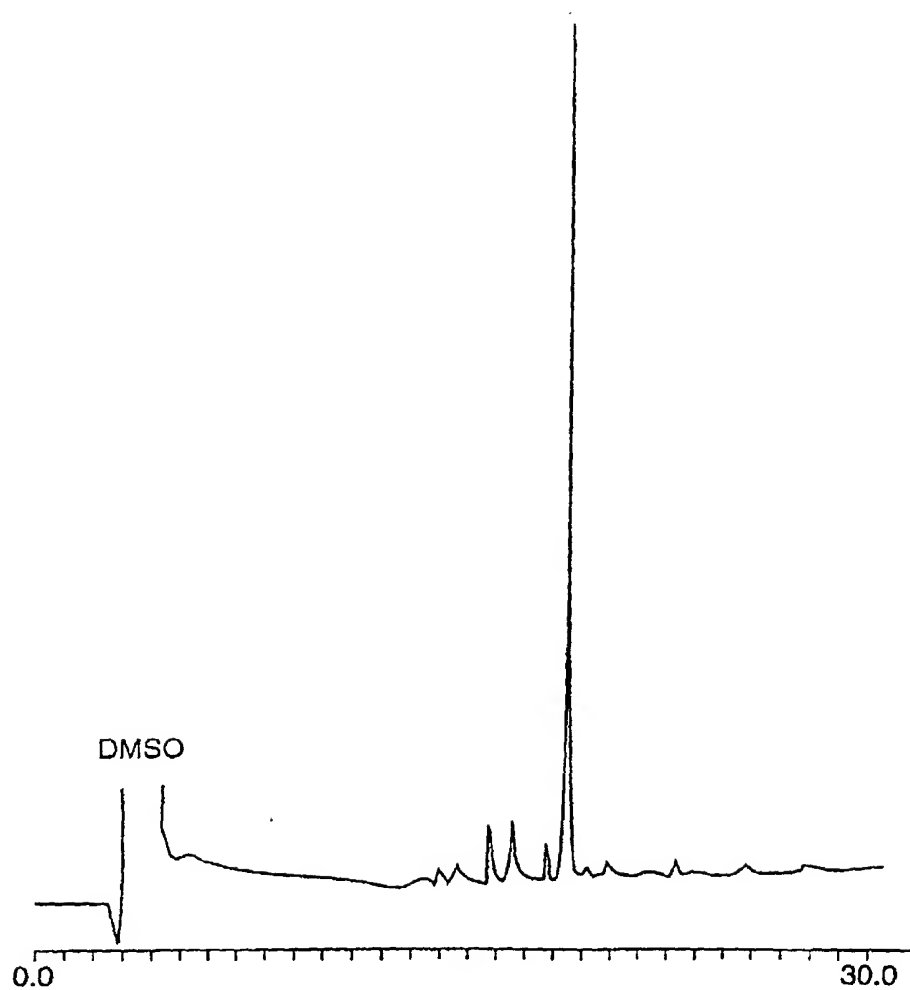


FIG. 3

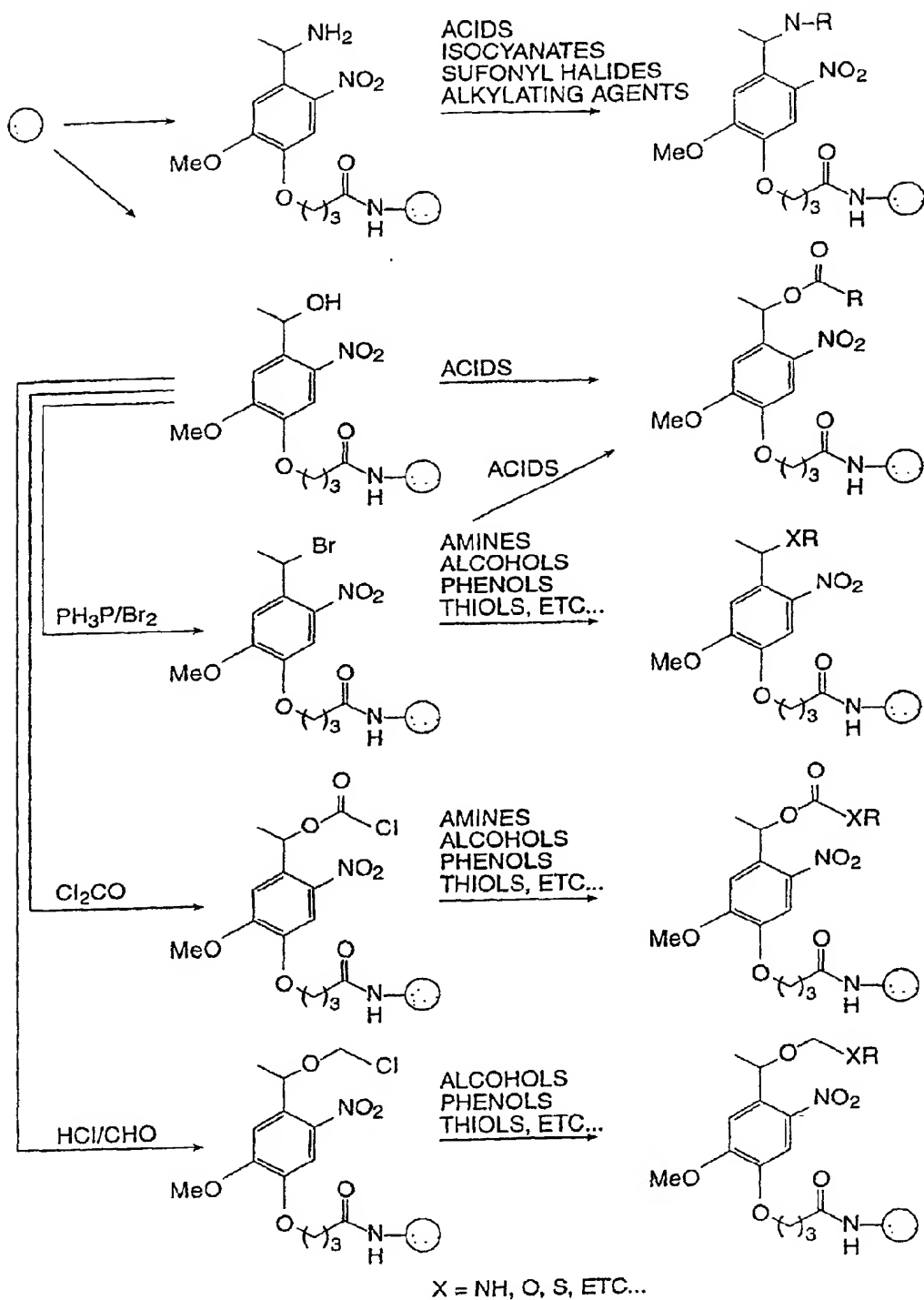


FIG. 4

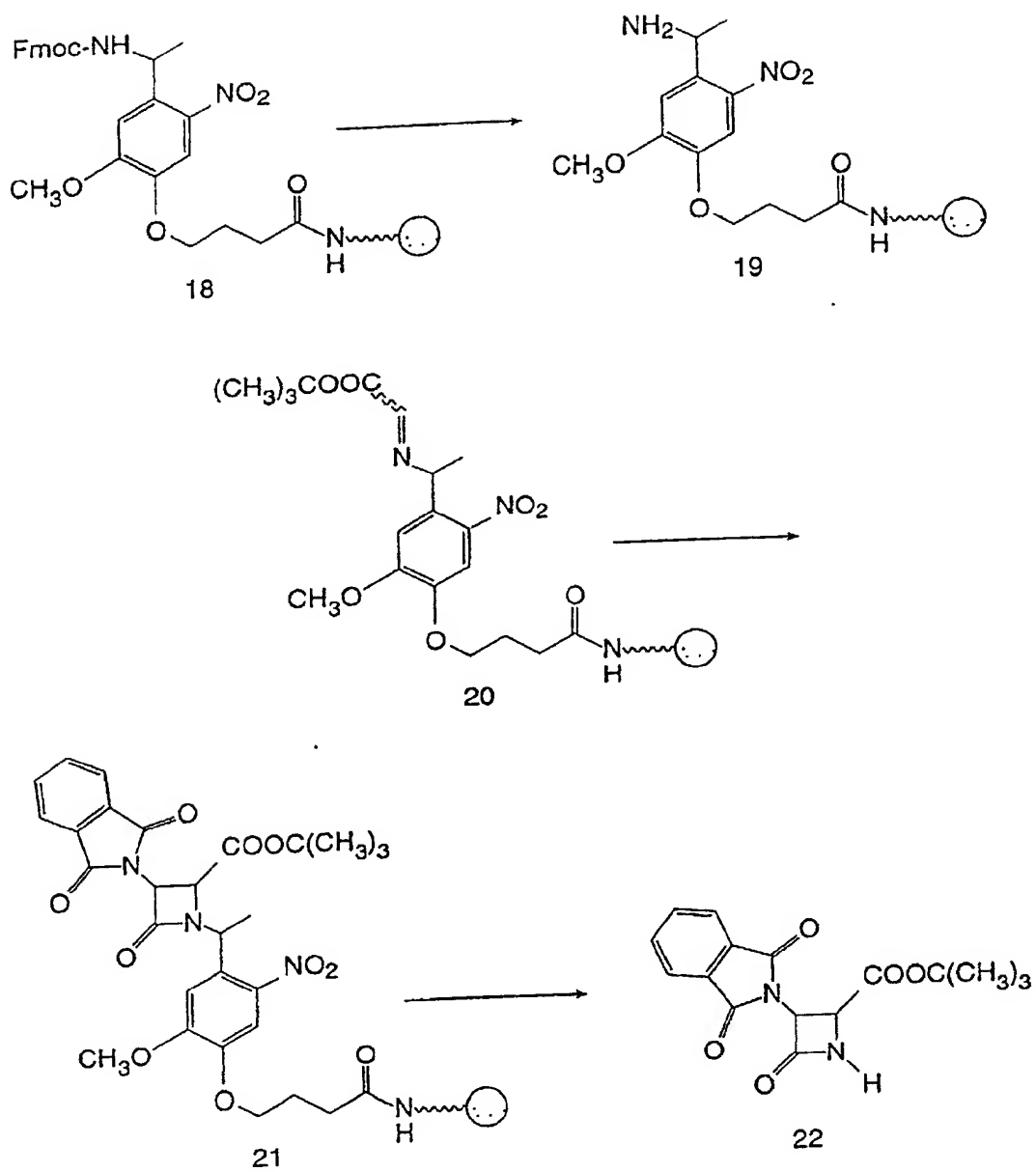


FIG. 5